NUCLEAR ENERGY

MAY, 1960 THREE SHILLINGS & SIXPENCE

621

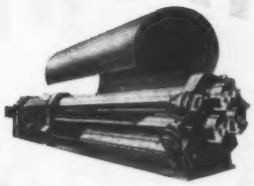
THE JOHN CRERAR LIBRARY
MAY 18 1960

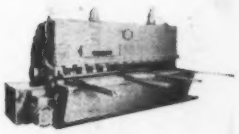
Swiss MACHINERY IN GREAT BRITAIN

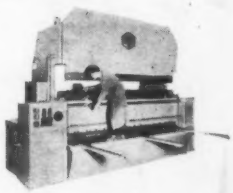
Well over a hundred Haemmerle Swiss-made Hydraulic Guillotines, Press Brakes and Universal Sheet Metal, Trimming, Rolling and Forming machines are in constant use in engineering establishments throughout Great Britain. Arrangements can be made for potential customers to attend practical demonstrations should they so desire. Fully illustrated literature is available on request.

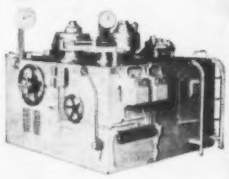
Electrically operated screw-luffing crane installed at Tilbury for the Port of London Authority by Stothert & Pitt Ltd.

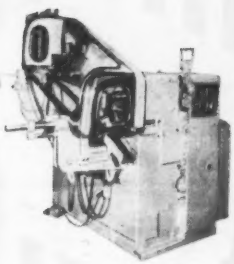
Oil Hydraulic Press Brake supplied to Stothert & Pitt Ltd. Manufactured by HAEMMERLE A.G. of Switzerland.











HAMMERLE ZOFINGEN

HAEMMERLE (LONDON) LIMITED

LIVINGSTONE HOUSE BROADWAY LONDON SWI

Telephone: TRAfalgar 4262/3 Telegrams: Haemmerle Sowest London Cables: Haemmerle London

DAWNAYS
STEELWORK

Specialists in the design
fabrication and erection of riveted
and welded steel-framed structures
of every description

DAWNAYS LIMITED
BRIDGE & STRUCTURAL ENGINEERS

STEELWORKS RD., BATTERSEA, LONDON, S.W.11.
Telephone BATTERSEA 2525 (10 lines)

Also at
SWANSEA, CARDIFF, WELWYN GARDEN CITY, NORWICH, HULL,
SOUTHAMPTON, ROMFORD, VICTORIA STREET S.W.1

NEW

Vertical Jet

HIGH VELOCITY DISCHARGE

Brooks' ' Vertical Jet ' Units ensure positive dispersion high above roof level—preventing extracted corrosive elements attacking roof coverings and re-entry of exhaust into building.

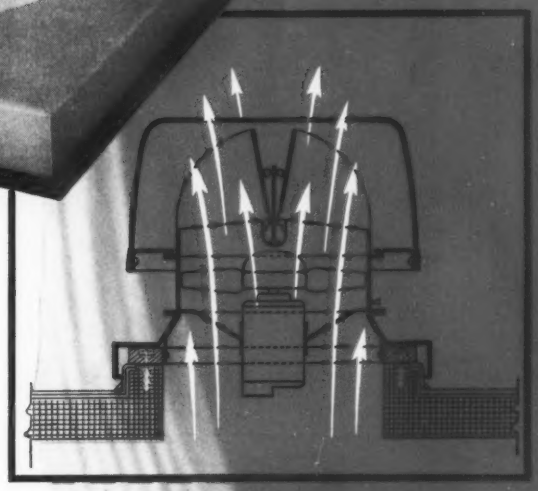
Ruggedly constructed with Hot-Dip galvanized steel base and discharge head. Anodized Aluminium alloy automatic shutters with life-lubricated bearings. Moulded glass fibre weather shield. Aerofoil fan with galvanized casing. Totally enclosed motor and external lubricators. Alternatively with Propeller type fan.

Exhaust capacity range 800 to 23,000 c.f.m.

SPECIFICALLY DESIGNED FOR ALL APPLICATIONS DEMANDING POSITIVE EXTRACTION OF INJURIOUS GASES, GREASE LADEN FUMES, SMOKE, EXCESS HEAT OR AIRBORNE DUST.

Illustration shows Flat Roof Type. Units also supplied with bases to suit Pitched Roof construction.

FULL DETAILS ON REQUEST



BROOKS

fan-powered

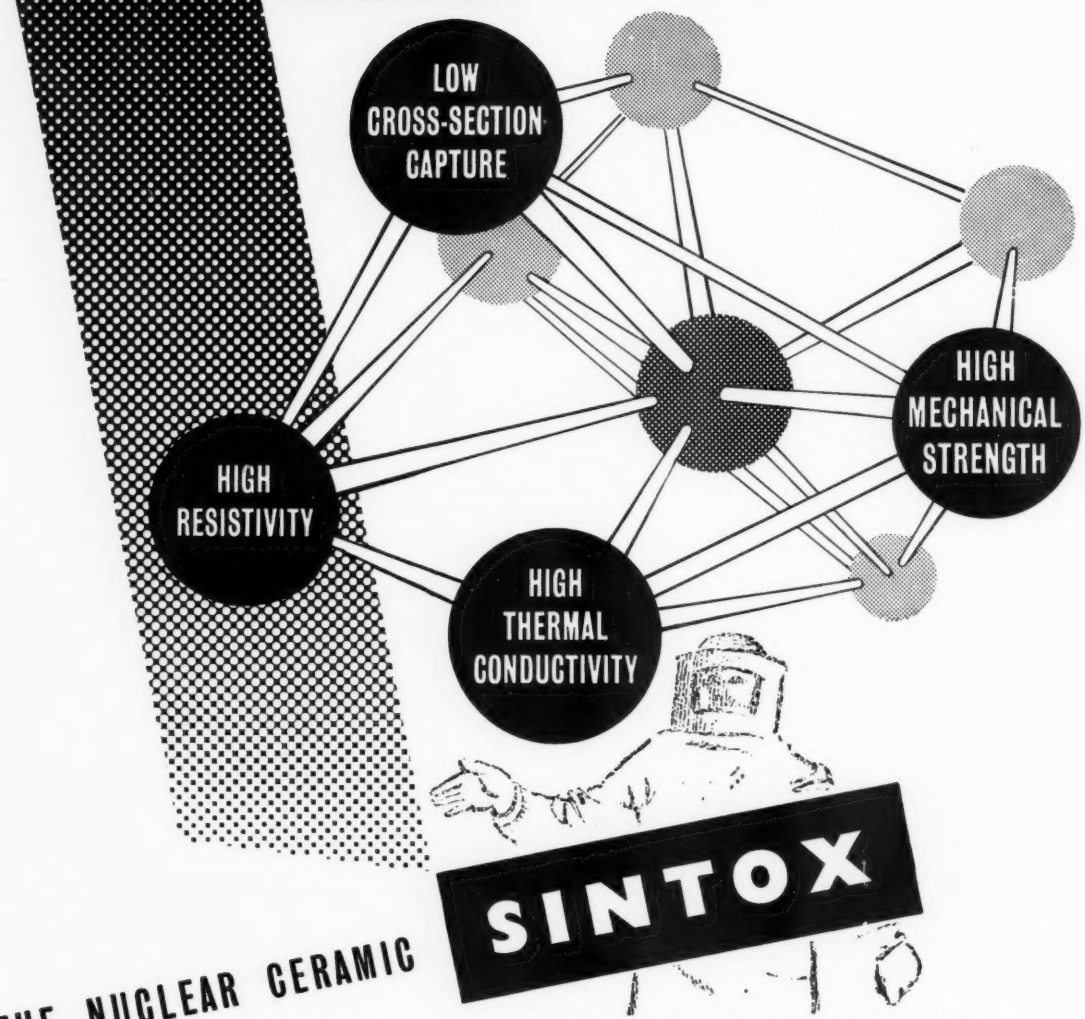
VENTILATION UNITS

BROOKS VENTILATION UNITS LIMITED

TRAFALGAR HOUSE GREAT NEWPORT STREET · LONDON W.C.2 · *Telephone: COVent Garden 1255/6*

Branch Office: CROMFORD HOUSE, CROMFORD COURT MANCHESTER 4

what are the advantages of SINTOX alumina ceramics?



THE NUCLEAR CERAMIC

These qualities have led to the use of SINTOX ceramics in many branches of engineering.

For the nuclear engineer a new grade of SINTOX—known as FF1—has been developed. In addition to its other attractive features, nuclear SINTOX has a low cross-section capture combined with compatibility with most materials used in reactor design. It is versatile in the production of a wide range of shapes and sizes and is particularly suitable for insulating parts in control gear and mechanical support members. White in colour, this new ceramic has already taken a leading place in the design and development of components for nuclear reactors.

LATINA NUCLEAR POWER STATION

Following its successful application in the nuclear power stations at Bradwell, Berkeley, Hunterston and Hinkley Point, SINTOX is now being incorporated in the design for the Latina Nuclear Power Station.

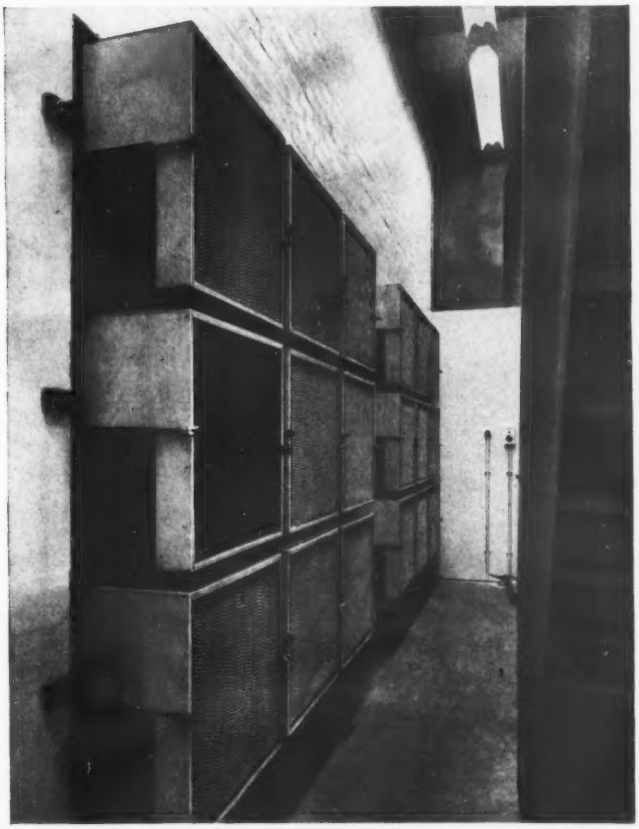
STAS

For full information write to the
SINTOX TECHNICAL ADVISORY SERVICE, LODGE PLUGS LIMITED, RUGBY.

VOKES 'ABSOLUTE' FILTERS for the arrestation of toxic particles

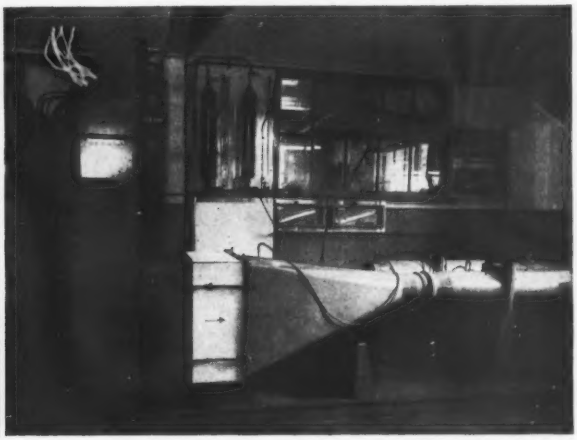
Vokes 'Absolute' filters have been developed for applications where radioactive and other toxic dusts may be encountered, and an extremely high degree of efficiency is therefore required. The filters have a guaranteed efficiency of at least 99.95% against particles in the 0.1 to 0.5 micron range, each panel being individually tested against a methylene blue dust cloud. Unlike many filters of this efficiency, the Vokes 'Absolute' is compact and light weight and the use of a special paper medium combined with an absence of metal parts facilitates the disposal of a contaminated panel.
Special variations of the 'Absolute'—High Humidity, High Temperature, Flameproof and High Acid Resistance types—use a glass paper medium with *an efficiency as high as* 99.99%.

Please write for further details.



A bank of Vokes 55 'Absolute' filters specified by the Ministry of Works for the ventilation plant (Extract) in the High Activity Materials Handling Building, Harwell. Vokes 44 'Absolute' panels are used on the intake.

A pressure-suited operator changing a filter in the ventilation system of the G.E.C. beryllium laboratory at Erith, where beryllium dust if not trapped could endanger human lives. Other Vokes filters are fitted to equipment used in the laboratory.



The methylene blue test rig—part of the equipment in the large Vokes filter laboratories at Henley Park. Guaranteed performance figures are stencilled on each filter case.

VOKES

VOKES LTD · HENLEY PARK · GUILDFORD · SURREY

Tel: Guildford 62861 (6 lines) Telegrams & Cables: Vokesacess, Guildford, Telex. Telex: 13-535 Vokesacess, Gfd.

Vokes Australia Pty. Ltd. Sydney. Represented throughout the World.

V528

Put NEWTHERM to any test!

NEWTHERM Calcium Silicate insulation manufactured solely by NEWALLS is the most versatile material you can use for application up to 1400°F. Try it. Put a sample section or slab on part of your plant and *prove for yourself* its outstanding ability to withstand impact and water damage.

LIGHTNESS

Weight - for - weight, NEWTHERM compares favourably with many materials far inferior in thermal efficiency and strength. This light weight is evidenced in the handleability of NEWTHERM, which even in the largest sections can easily be carried in one hand.

MOISTURE RESISTANCE

You can immerse NEWTHERM in water and its strength remains largely unimpaired. Nor does it become deformed when in contact with moisture, thus work-in-progress need not be covered. Wherever damp or humid conditions pertain, NEWTHERM is the logical material to use.

STRENGTH

Of major advantage on remote sites, NEWTHERM is unusually strong and rigid, and can withstand rough handling in transit and erection. In the case of vulnerable large-diameter sections, the hard surface offers excellent protection.

EASY APPLICATION

Supplied in pre-formed sections and slabs, NEWTHERM is available in a wide range of standard sizes (and also as plastic). The smooth surface and straight edges permit easy and speedy fitting, with minimum joints and neat finish.

NEWALLS INSULATION CO. LTD.

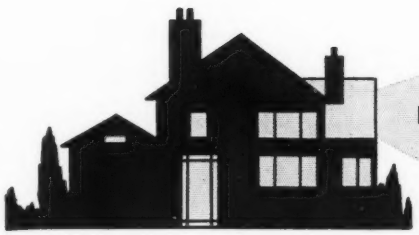
Head Office: WASHINGTON, CO. DURHAM, ENGLAND.
A member of the **TURNER & NEWALL ORGANISATION**
Offices & Depots at: LONDON, GLASGOW, MANCHESTER, NEWCASTLE UPON TYNE, BIRMINGHAM, BELFAST, DUBLIN, BRISTOL & CARDIFF.
Agents and Vendors in most markets abroad.

NEWALLS (Reg'd Brand)

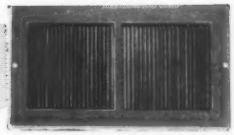
NEWTHERM calcium silicate insulation

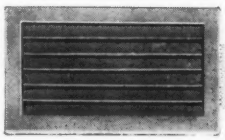
Please ask for your copy of the NEWTHERM booklet. Packed with information on limiting temperatures, thermal conductivity, compressive strength, applicational details, etc., it's a must for your bookshelf. Copies available from sole manufacturers—NEWALLS

GRILLES | and REGISTERS

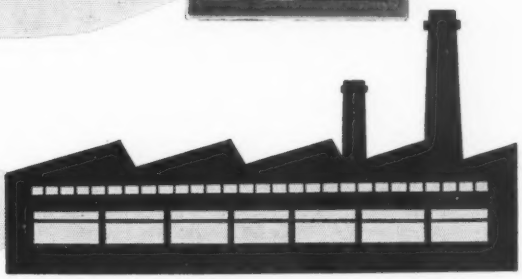


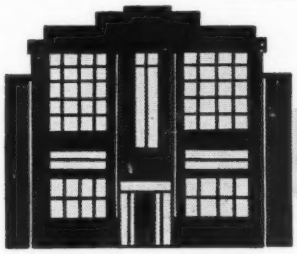
residential



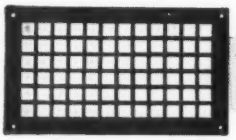


industrial

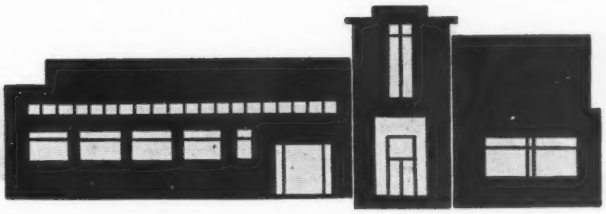




commercial



medical



Phone or write for catalogue of grilles and registers

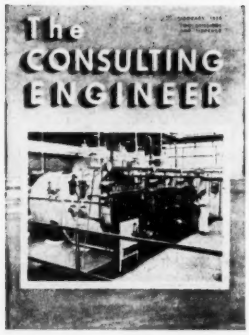
ACE TRADE MARK

AIR CONDITIONING & ENGINEERING (N.I.) LTD.,

TANDRAGEE, CO. ARMAGH, NORTHERN IRELAND.

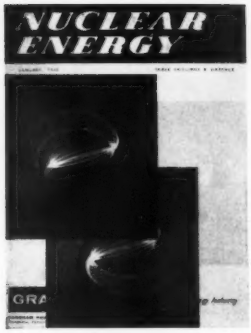
P.O. BOX 8, PORTADOWN, N. IRELAND, PHONE TANDRAGEE 214

The PRINCES PRESS Group



THE CONSULTING ENGINEER
Detailed, profusely illustrated articles, news and information. Monthly. 3/6d. (Postage 2/-) 12 issues 42/- post free.

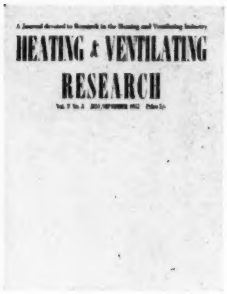
Printed and published
by
PRINCES PRESS LTD.
147, Victoria Street,
Westminster,
London, S.W.1
Telephone: Victoria 6423



NUCLEAR ENERGY
All aspects of nuclear energy in industrial use, science, medicine, education, etc. Monthly. 3/6d. (postage 2/-) 12 issues 42/- post free.

HEATING & AIR CONDITIONING
Lively, authoritative coverage of trade and technical matters in heating, ventilating and allied fields. Monthly. 3/6d. (postage 2/-) 12 issues 42/- post free.

THE CIVIL ENGINEER
Articles, news and pictures and trade and technical matters in the civil engineering field. Monthly. 3/6d. (postage 2/-) 12 issues 42/- post free.



HEATING & VENTILATING RESEARCH
Detailed accounts of some of the interesting research work carried out at home and abroad, Quarterly. 10/6, or 42/- per annum post free.

EUROPEAN ENGINEERING
News, trade features and technical articles for buyers and sellers within Europe and from Europe to the rest of the world. A separate section for each European country or bloc. Monthly. 5/- (postage 2/-); 12 issues 80/- post free.

Also available . . .

The Consulting Engineers Who's Who & Year Book 1960

Published in Collaboration with the Association of Consulting Engineers.
In addition to Members' and Firms' Who's Who sections, contains much other useful information. Cloth bound, 8vo. 42/- post free.

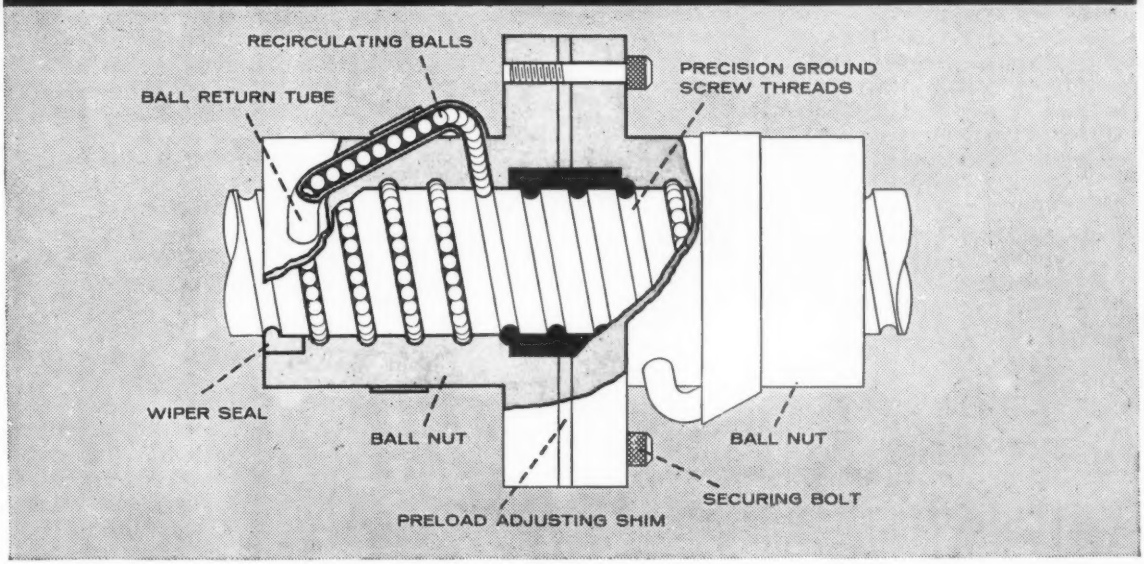
Temperature & Degree Days—Season 1958-59

Monthly tables of official min/max/mean temperatures and degree days.
Pocket Size. 1/- post free.

MATHEMATICS IS EASY—by D. S. Watt, BSc, pp. 488. Figs. 109. Cloth bound. 48s. net. With this book it is possible to learn mathematics from the first equation to the most advanced calculus.

PHYSICS IS EASY—by D. S. Watt, BSc, pp. 560. Figs. 123. Cloth bound. 63s. net. Second in the 'Easy' series, bringing a fascinating subject within the reach of all. Profusely illustrated with photographs and drawings.

Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...



. . . ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of −52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

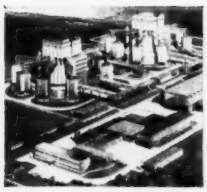
** Complete technical and manufacturing co-operation with Beaver Precision Products Inc., Detroit.*

For further information please write to J. B. Starky, Sales Manager (Beaver Products Division), Bristol Siddeley Engines Limited, PO Box 17, Coventry, England.

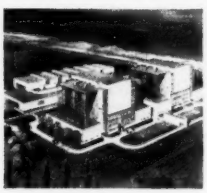
BRISTOL SIDDELEY ENGINES LIMITED

VOKES GENSPRING have been awarded contracts for the supply of pipe suspension equipment for all current Nuclear Power Stations

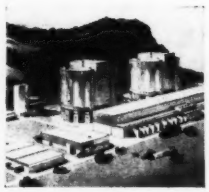
Vokes Genspring constant support hangers—capable of supporting loads up to 97,800 lbs and travels up to 12"—have been specified by all five members of the Nuclear Consortia for each of the first five Nuclear Power Stations. Gensprings have already been installed at Calder Hall A & B and Chapel Cross A & B where their success in handling the movement of piping caused by temperature changes is rapidly making them an automatic choice for pipework support in the construction of Nuclear Power Stations.



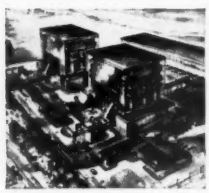
BERKELEY
(A.E.I. — John Thompson Nuclear Energy Co. Ltd.)



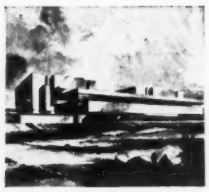
BRADWELL
(The Nuclear Power Plant Company Ltd.)



HUNTERSTON
(G.E.C. — Simon Carves Group)



HINKLEY POINT
(English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group)



TRAWSFYNYDD
(Atomic Power Constructions Ltd.)

(An impression by Mr. Basil Spence, Consultant Architect to Nuclear Civil Constructors, showing how the design blends into the landscape of Snowdonia)

Vokes Genspring SUSPENSION SYSTEMS

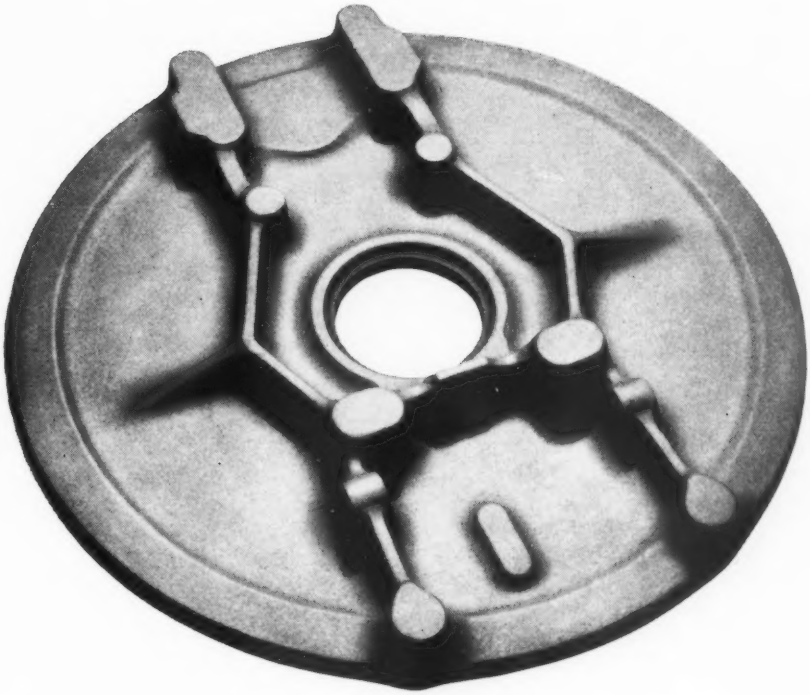
VOKES GENSPRING LIMITED · GUILDFORD · SURREY

Telephone: Guildford 62861 (6 lines) Telex: 13-535 Vokesacess, Guildford. Telegrams & Cables: Vokesacess, Guildford, Telex.

A member of the VOKES Group.

VG48

THE SPECIAL TECHNIQUES OF H.D.A.



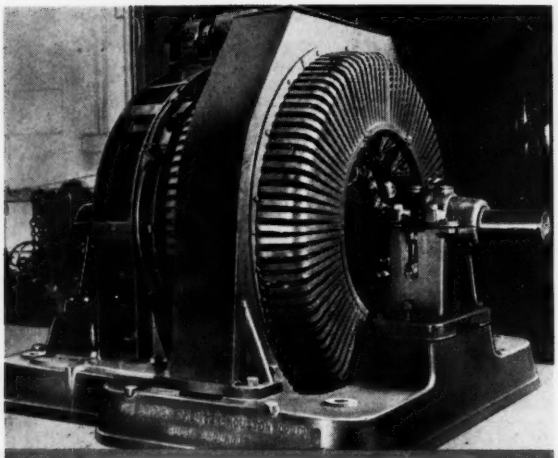
Precision Forgings in Nimonic. The techniques developed by H.D.A. for the forging of light alloys have now been adapted to the precision forging of Nimonic and other alloys. Components such as the support housing forging shown here can go into service with the minimum of machining. **This saves time; this saves money; this saves effort; H.D.A. can do it.**

(Forging for Rolls-Royce Ltd.)

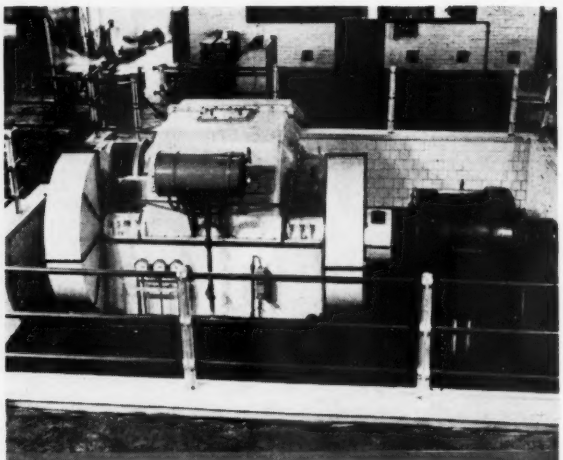
H.D.A. PERFECTION IN FORGING

HIGH DUTY ALLOYS LTD, SLOUGH, BUCKS.

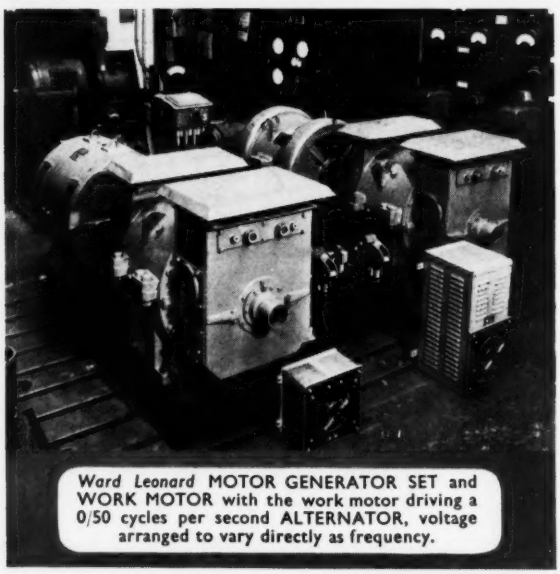
Electrical Plant for Special Applications



270/67.5 h.p. COMMUTATOR MOTOR, speed 375/95 r.p.m.



FOUR 400 h.p. ROLLING MILL MOTORS by *English Electric Co.*, 738 r.p.m. to final 30 r.p.m. With control gear.



Ward Leonard MOTOR GENERATOR SET and WORK MOTOR with the work motor driving a 0/50 cycles per second ALTERNATOR, voltage arranged to vary directly as frequency.

Send Us Your Enquiries For:

FREQUENCY CHANGER EQUIPMENT
WARD LEONARD SETS
MOTOR GENERATOR SETS
PLATING AND ANODISING GENERATORS
A.C. AND D.C. MOTORS
ALTERNATORS
WELDING GENERATORS
TRANSFORMERS
SWITCHGEAR—HAND AND AUTOMATIC

FOR ROTATING ELECTRICAL MACHINES TO SPECIAL REQUIREMENTS

THE 600 GROUP OF COMPANIES

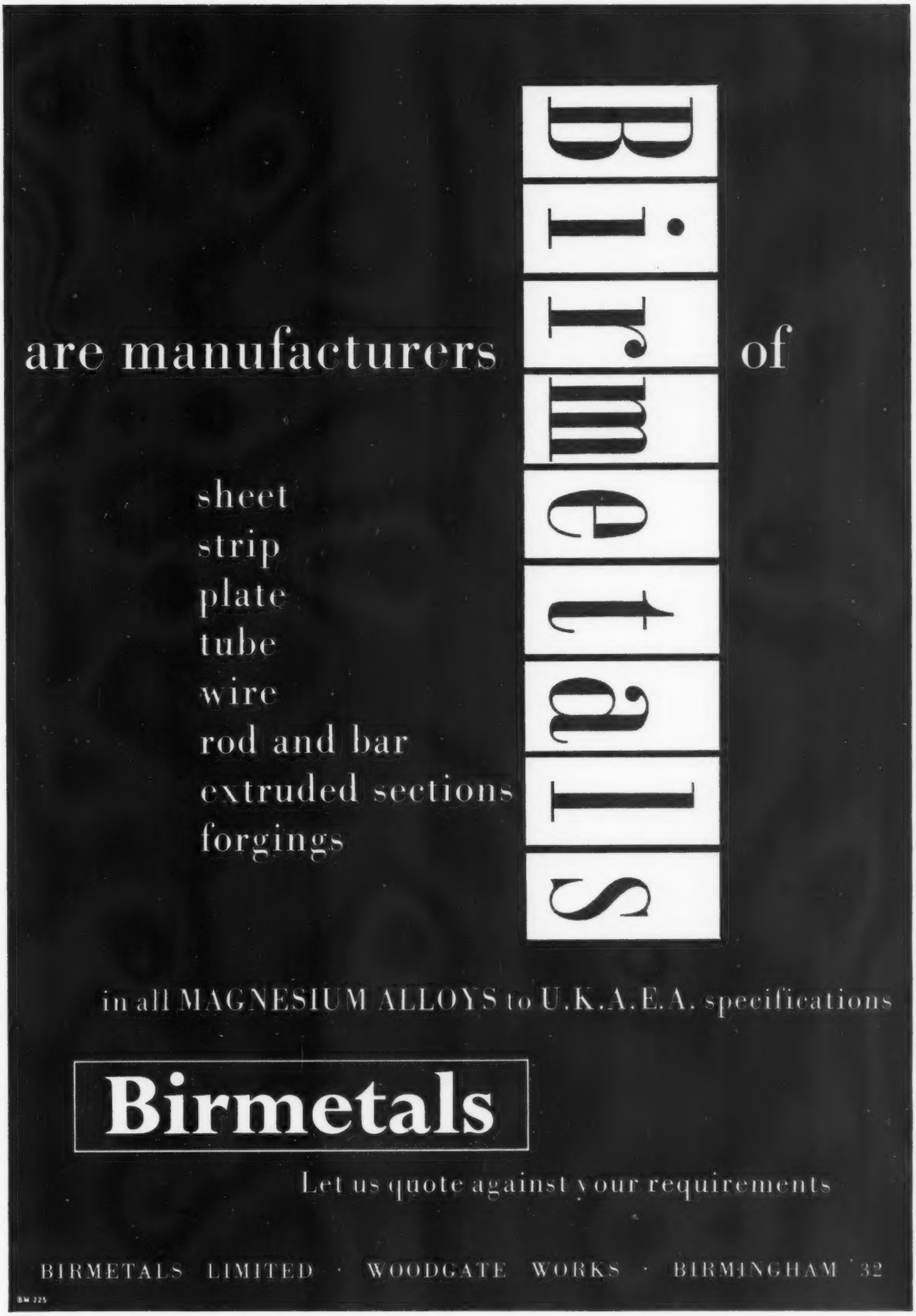
GEORGE COHEN

SONS AND COMPANY LIMITED

WOOD LANE, LONDON, W.12 Telephone: SHEpherds Bush 2070

STANNINGLEY, Nr. LEEDS Telephone: Pudsey 2241

And at Kingsbury (Nr. Tamworth), Manchester, Glasgow, Bath, Swansea, Newcastle-on-Tyne, Belfast, Sheffield, Southampton


Birmetals
are manufacturers of
sheet
strip
plate
tube
wire
rod and bar
extruded sections
forgings
in all MAGNESIUM ALLOYS to U.K.A.E.A. specifications
Birmetals
Let us quote against your requirements
BIRMETALS LIMITED · WOODGATE WORKS · BIRMINGHAM 32
BM 225

a specialised service

in heat transfer surfaces

Engineers and contractors frequently need more than a standard service in heat transfer surfaces. We design and supply this equipment to the individual requirements of every branch of industry, and maintain the highest standards of workmanship throughout. We welcome your enquiries and will be pleased to send details of our products and service on request.

HEATING COILS.

For all systems, using steam or hot water.

COOLING COILS.

Brine, Chilled Water and Direct Expansion Refrigerants including coils for Solvent Recovery.

AIR-COOLED CONDENSERS.

A wide range of standard models, covering small and large air-flows.

United Air Coil Ltd

13 New Bridge Street, London, E.C.4
Telephone: FLEet Street 2295/6
Telegrams: AIRCOILIM LONDON

PROCEEDINGS OF THE SECOND UNITED NATIONS INTERNATIONAL CONFERENCE ON THE PEACEFUL USES OF ATOMIC ENERGY

Geneva, September, 1958 English Edition

33 VOLUMES

NOW AVAILABLE

Vol. 1	Progress in Atomic Energy—525 pages	£4. 9. 0 stg.
„ 33	Index of The Proceedings	£5.18. 0 stg.
NUCLEAR MATERIALS		
Vol. 2	Survey of Raw Material Resources—846 pages	£6.12. 0 stg.
„ 3	Processing of Raw Materials—612 pages	£5. 6. 0 stg.
„ 4	Production of Nuclear Materials and Isotopes—644 pages	£5.18. 0 stg.
„ 5	Properties of Reactor Materials—627 pages	£5. 0. 0 stg.
REACTORS		
Vol. 6	Basic Metallurgy and Fabrication of Fuels—720 pages	£6. 9. 0 stg.
„ 7	Reactor Technology—858 pages	£7. 0. 0 stg.
„ 8	Nuclear Power Plants, Part I—584 pages	£5. 0. 0 stg.
„ 9	Nuclear Power Plants, Part II—538 pages	£6. 5. 0 stg.
„ 10	Research Reactors—548 pages	£6.12. 0 stg.
„ 11	Reactor Safety and Control—608 pages	£5.11. 0 stg.
„ 12	Reactor Physics—774 pages	£6.12. 0 stg.
„ 13	Reactor Physics and Economics—635 pages	£6.12. 0 stg.
PHYSICS		
Vol. 14	Nuclear Physics and Instrumentation—492 pages	£6. 0. 0 stg.
„ 15	Physics in Nuclear Energy—476 pages	£4. 9. 0 stg.
„ 16	Nuclear Data and Reactor Theory—744 pages	£6.12. 0 stg.
„ 30	Fundamental Physics—342 pages	£3.15. 0 stg.
CHEMISTRY		
Vol. 17	Processing Irradiated Fuels and Radioactive Materials—709 pages	£6. 9. 0 stg.
„ 18	Waste Treatment and Environmental Aspects of Atomic Energy—624 pages	£5.18. 0 stg.
„ 19	The Use of Isotopes: Industrial Use—366 pages	£4. 9. 0 stg.
„ 20	Isotopes in Research—296 pages	£3.11. 0 stg.
„ 28	Basic Chemistry in Nuclear Energy—686 pages	£6.12. 0 stg.
„ 29	Chemical Effects of Radiation—475 pages	£5. 4. 0 stg.
BIOLOGY AND MEDICINE		
Vol. 21	Health and Safety: Dosimetry and Standards—249 pages	£3.15. 0 stg.
„ 22	Biological Effects of Radiation—552 pages	£5. 4. 0 stg.
„ 23	Experience in Radiological Protection—468 pages	£5. 4. 0 stg.
„ 24	Isotopes in Biochemistry and Physiology, Part I—308 pages	£3.19. 0 stg.
„ 25	Isotopes in Biochemistry and Physiology, Part II—312 pages	£3.19. 0 stg.
„ 26	Isotopes in Medicine—460 pages	£4.12. 0 stg.
„ 27	Isotopes in Agriculture—455 pages	£5. 0. 0 stg.
CONTROLLED FUSION		
Vol. 31	Theoretical and Experimental Aspects of Controlled Fusion—390 pages	£5. 6. 0 stg.
„ 32	Controlled Fusion Devices—462 pages	£5. 6. 0 stg.

Abridged French and Spanish editions (13 volumes each) now in preparation

For further information consult your bookstore or:

UNITED NATIONS

Sales Sections (Atomic Energy)

Geneva, Switzerland

Brochures available on request

NUCLEAR ENERGY

Vol. 14 No. 144

MAY, 1960

CONTENTS

	PAGE
Medical Reactors—A Review of U.S. Programme	205
Institution of Nuclear Engineers—April Council Meeting	210
Radiation Protection—New Approach to Measurements Needed	212
Nuclear Training in France	216
Nuclear Shipping—Safety Proposals	219
Gas-lubricated Bearings	220
Radiation in the Chemical Industry—Part II, by F. R. Paulsen	221
N-Aircraft Test Rig	224
Book Reviews	225
Equipment and Materials	226
Keeping up the Standard	228
Britain's N-Twins—Berkeley and Bradwell	230
Westminster Talks About	232
People in the N-News	233
Nuclearist Writes	234
Nuclear News	235

Contributors are invited to submit material for editorial consideration. Any matter which is required to be returned, should it prove unsuitable, should be accompanied by a stamped, addressed envelope. The Editor, to whom all contributions should be addressed, cannot accept responsibility for loss or damage to any material.

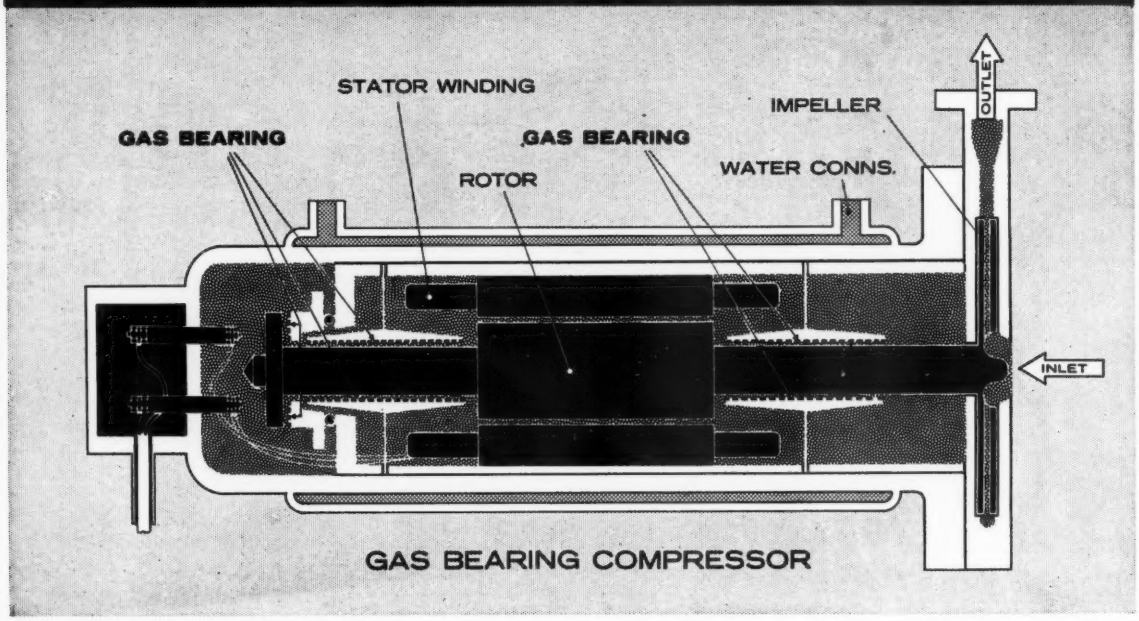
Subscriptions

Sterling Area :—12 monthly issues 42s. 0d. (including postage)

Americas :—$10.00

Other Countries :—As Sterling Area

Gas bearing compressors–
totally enclosed, lubricant free – circulate gases
up to 700 C, 2,000 psi, without contamination . . .



...ANOTHER ENGINEERING ADVANCE BY BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce gas bearing compressors. The range covers a very wide performance capacity, from 0°—700°C gas operating temperature, 15—2,000 psi and 0.5—2,000 hp power input.

These Bristol Siddeley compressors have been designed specifically for systems where contamination from lubricants or leakage to atmosphere cannot be tolerated. Each unit, fitted with hydrodynamic-type gas bearings, is totally enclosed and no seals are required between the impeller and the bearings.

Gas bearings have several great advantages over oil lubricated bearings: the load-carrying capacity increases with speed, temperature and pressure; the bearings are supported on a film of the gas which is being circulated in the system, so there is no metal-to-metal contact under operating conditions and wear and maintenance are reduced to an absolute minimum; perfect cleanliness is preserved at all times.

Applications

Bristol Siddeley gas bearings were developed originally to meet the extremely fine limits of operating purity and precision of manufacture demanded by the advent of nuclear engineering. But gas bearings have many other applications where a rotating shaft must be supported in such a way that no contamination and leakage can be allowed and where the supply of chemically pure fluids or gases is essential: in the textile, chemical engineering, pharmaceutical, food storage and processing industries, to name but a few.

For further information about Bristol Siddeley gas bearing compressors and gas bearings, please write to H. J. Prince, Sales Manager, Reactor Components Division, Bristol Siddeley Engines Limited, P.O. Box 17, Coventry, England.

BRISTOL SIDDELEY ENGINES LIMITED

NUCLEAR ENERGY

Journal of the Institution of Nuclear Engineers

Published Monthly *Price 3s. 6d.*

Editorial Director
J. B. Pinkerton, M.Cons.E., M.I.Mech.E., M.I.Nuc.E.

Editor
Ronald L. Sharp

Science Editor
D. S. Watt, B.Sc., M.I.Nuc.E.

Assistant Editor
Tony Rea

Advertisement Manager
Ernest Hill

Group Advertisement Controller
A. W. St. John Dillon

Art Editor
Arnold E. Hooton

International Editors

Australia: Prof. S. Bashkin, *Australian National University, Canberra;* Prof. Sir Leslie Martin, FRS, *Universities Commission;* Prof. H. Messel, *University of Sydney;* Prof. H. C. Webster, DSc, PhD, MINucE, *University of Queensland;* Prof. L. C. Woods, *University of New South Wales.*

Belgium: Prof. Dr. J. L. Verhaeghe, *Ruksuniversiteit, Ghent.*

British West Indies: T. A. Jones, *Imperial College of Tropical Agriculture, Trinidad.*

Canada: Prof. A. R. Edis, *McGill University, Montreal;* Prof. A. C. Ghosh, *Carleton University, Ottawa;* Dr. G. W. Holbrook, *Royal Military College, Ontario.*

Ceylon: Prof A. W. Mailvaganam, *University of Ceylon, Colombo.*

Denmark: Prof. Dr. Phil. V. Thorsen, *Danmarks Farmaceutiske Hojskole, Copenhagen.*

Federal Republic of Germany: Prof. Dr. med.h.c. Dr.-Ing.E.h. Dipl.-Ing. Leo Brandt, *Ministerium fur Wirschaft und Verkehr, Dusseldorf.*

Holland: Ir. J. J. Arlman, *N.V. Philips-Duphar, Isotopes Commercial Dept., Amsterdam;* Ir. H. R. Kleyn, *Reactor Instituut, Delft;* Prof. Dr. A. C. Schuffelen, MINucE, *Landbouwhogeschool, Wageningen.*

India: Prof. B. M. Anand, *Panjab University, Hoshiarpur;* Prof. D. R. Bhawalkar, MINucE, *University of Saugar;* P. S. Gill, *Muslim University, Aligarh;* Dr. S. P. Pandya, *Gujarat University, Ahmedabad;* Dr. N. R. Tawde, *Karnatak University, Dharwar.*

Israel: Prof. Walter Fagan, *Israel Institute of Technology, Haifa.*

Japan: Dr. Masao Kato, *University o, Tokyo;* Prof. Masaichi Mashima, *Keio University, Tokyo;* Prof. Keiji Nishioka, *Faculty of Engineering, Kanazawa University, Uenohon-Machi;* Dr. Noriyuki Sakikawa, *Tokyo Institute of Technology, Ookayama Meguro-ku, Tokyo.*

New Zealand: F. J. Llewellyn, *University of Canterbury, Christchurch;* Prof. D. Walker, *Victoria University of Wellington.*

Norway: L. Koren Lund, MINucE, *Gullang Kjem. Fabr., Drammen.* Prof. dr. B. Trumpy, *Universitetet I Bergen.*

Pakistan: Dr. Abdul Majid Mian, MINucE, *Peshawar University.*

South Africa: Prof. J. A. Gledhill, *Rhodes University, Grahamstown;* Dr. H. R. Lemmer, *University of Pretoria;* Prof. F. R. N. Nabarro, *University of the Witwatersrand, Johannesburg;* Dr. J. P. F. Sellschop, *Witwatersrand University, Johannesburg.*

Sweden: Dr. Rune Alphonce, *Hogre tekniska laroverket, Orebro.*

United Arab Republic: Dr. S. I. El-Sisi, *Assiut University;* Dr. M. Z. Hathout, *Assiut University.*

United Kingdom: Prof. A. Charlesby, *Royal Military College of Science, Shrivenham;* M. G. Cooper, MA(Cantab), AMICE, *University of Cambridge;* Dr. N. S. Grassam, MINucE, *University of Southampton;* Dr. T. G. Pickavance, *UKAEA, Harwell.*

United States: Prof. G. Arfken, *Miami University, Oxford, Ohio;* Prof. J. P. Bradish, *Marquette University, Milwaukee;* Prof. P. R. Camp, *Polytechnic Institute of Brooklyn, New York;* Dr. L. Cochran, *University of Kentucky;* Dr. B. E. Cohn, *University of Denver;* Prof. B. Crasemann, *University of Oregon;* Dr. J. W. Culvahouse, *University of Oklahoma;* Prof. H. J. Ermenc, *Dartmouth College, New Hampshire;* H. J. Gomberg, *University of Michigan;* G. A. Greathouse, *University of Florida, Gainsville;* T. M. Hahn, Jnr., *Virginia Polytechnic Institute, Blacksburg;* Dr. W. W. Havens, Jnr., *Columbia University, New York;* G. A. Hawkins, *Purdue University, Lafayette, Indiana;* Prof. V. P. Henri, *Northeastern University, Boston;* Prof. M. J. Jakobson, *Montana State University, Missoula;* Prof. J. A. Lockwood, *University of New Hampshire, Durham;* Dr. J. K. Major, *Western Reserve University, Cleveland;* Dr. S. F. Malaker, *Newark College of Engineering, New Jersey;* A. C. Menius, Jnr., *University of North Carolina, Raleigh;* Dr. G. Minard, *Bucknell University, Lewisburg, Pennsylvania;* V. E. Parker, *Lousiana State University, Baton Rouge;* Dr. F. B. Porzel, *Illinois Institute of Technology, Chicago;* J. A. Sauer, *Pennsylvania State University;* G. K. Schoepfle, *Kent State University, Ohio;* M. Schwartz, *University of Louisville;* Prof. W. E. Stephens, *University of Pennsylvania, Philadelphia;* Dr. C. D. Thomas, *West Virginia University, Morgantown;* Prof. L. Titone, *Manhattan College, New York;* Prof. B. Tolbert, *University of Colorado, Boulder;* R. E. Turley, *University of Utah, Salt Lake City;* Dr. J. Walton, *Oregon State College, Corvallis;* Prof. J. B. West, *Oklahoma State University, Stillwater.*

U.S.S.R.: Prof. Sheglyayev, *Moscow Technical Institute.* Dr. S. A. Skvortzov, *Academy of Sciences.*

Yugoslavia: Dr. M. V. Susic, *Institute of Nuclear Sciences, Belgrade.*

147 VICTORIA STREET, LONDON, S.W.1 Telephone: VICtoria 6423-4

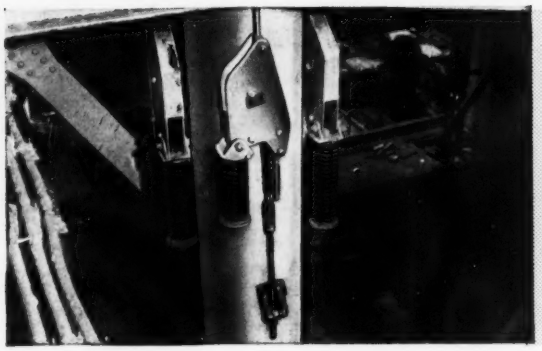
A PRINCES PRESS PUBLICATION

For controlled pipe movement . .

CON-TEN

REG. TRADE MARK

CONSTANT TENSION PIPE SUPPORTS



The Con-Ten system has not only been tested, but *proved* in industries and power stations all over the world. No matter what the load or the pipe movement, or the problems met, there is a Con-Ten to provide the most adequate and *permanent* support available. Loads from 100 lbs. to 14 tons and pipe movements up to 18" can be controlled by constant tension supports in the Con-Ten range.

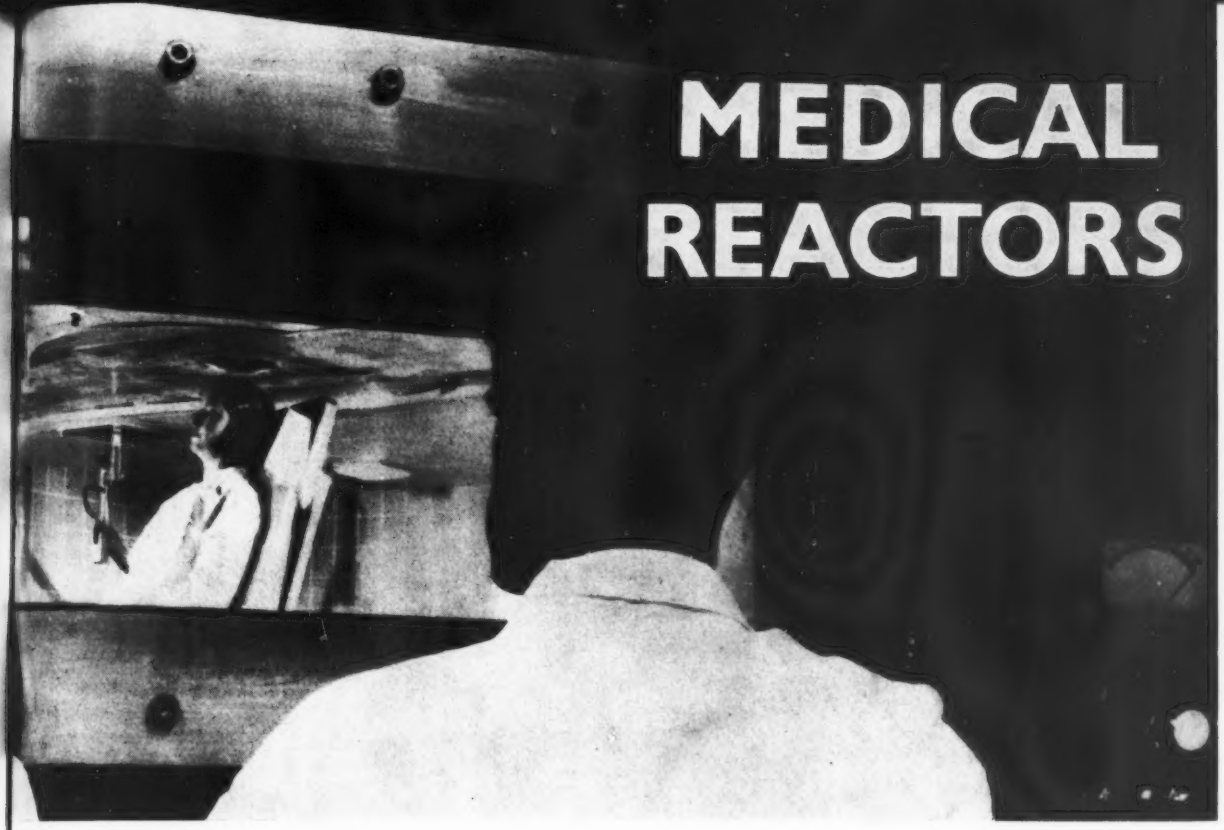
Contact us now for full information.

British Patent Nos. 474008, 720074, 720075, 697987, 816976, U.S.A. Patent No. 2129320.

BRITISH INDUSTRIAL

ENGINEERING COMPANY (STAFFS) LIMITED

CORONATION WORKS MARSH ROAD, TIVIDALE, TIPTON, STAFFS. Telephone: TIPTON 1223/3



MEDICAL REACTORS

A REVIEW OF U.S. PROGRAMME

THERE can be no more fitting recognition of the work of nuclear pioneers such as Marie Curie, Irene Joliot-Curie, François Joliot, and Enrico Fermi than that their painstaking researches be devoted more and more to the relief of the suffering of mankind than to the weapons of mass destruction which now hold the world in fear.

It would be safe to say that in every country where nuclear research has been undertaken, a very sizable portion of the financial burden goes towards medical aspects. This is not purely because the atomic investigational work brings its own special hazards, but because it may be fundamentally helpful in solving the many medical problems which beset the world long before atomic energy came into being.

To see how true this is, we have only to look at the medical and biological research programme inaugurated by the U.S. Atomic Energy Commission, which sponsors the world's greatest investigational activities in this particular field.

Although by the end of 1957 it was true that there had been no break-through in our knowledge of cancer, the nuclear programme had provided for the study of this major killing-disease a new and serviceable tool, the radio-isotopes, for use in all phases of research. Teletherapy, by means of cobalt-60, led to more rapid treatment of patients, but it is still too early to assess the merits (other than the financial ones) of the method. The treatment of cancer by radio-isotopes is limited in scope, and total cure is very rare, but the palliative value is undisputed.

Locating Tumours

One of the most encouraging and profitable fields of application for radio-isotopes has been in the localization of tumours, and it has been possible to obtain wonderful definition of the size and limits of intercranial lesions using the position-emitter, arsenic-74 with a coincidence-counting scanning technique. The information so obtained has enabled the surgeon to operate with increased certainty that he will be able to eradicate completely the tumour.

In 1946 only 30 American doctors were using isotopes in their work, but the total was over 3,000 by 1958. These isotopes included phosphorus-32 for leukaemia, polycythaemia, and certain forms of cancer, and the diagnosis of eye tumours; radio-gold to combat accumulation of fluid in cancer cases; radio-iodine in angina pectoris; strontium-89 for the beta-therapy of eye lesions; and Co60 for cancer treatment. The old method of inserting a flow-meter into blood vessels in studying blood circulation was replaced by the simple and effective technique of injecting radio-iodine-labelled human serum albumin, and studying the passage of the isotope around the body by means of the GM counter. Isotopes also proved invaluable for the study of abnormalities of function of kidney, liver, heart, spleen, brain, and pancreas.

Money Spent Increases

American expenditure on the biological and medical programme was $27.2m. in the fiscal year 1954, but had risen by 1957 to $33.1m. and to $40.5m. in 1958. This programme covers work done in the Commission's laboratories as well as in universities and hospitals.

What sort of work is included in this programme? The Oak Ridge Institute of Nuclear Studies had its medical division very early, as did

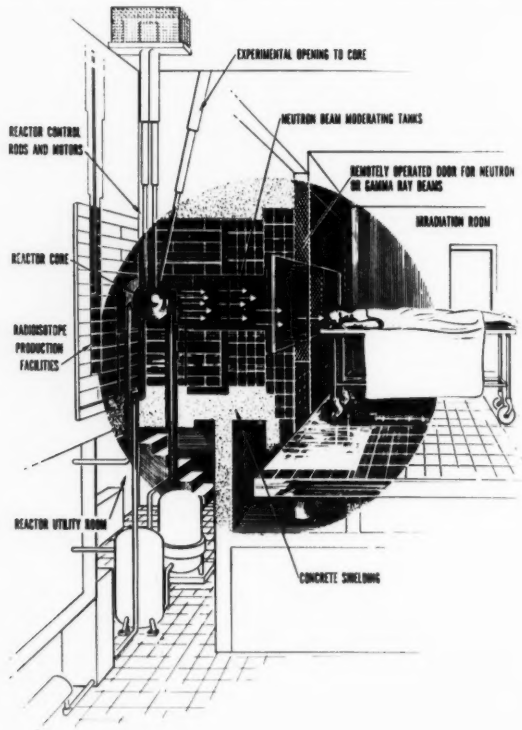
the University of California School of Medicine its radiological laboratory, and both of these were largely engrossed in cancer studies. Oak Ridge was principally interested in the use of caesium-137 and Co-60 for teletherapy, iodine-131 and the rare earths for clinical work, metabolism studies, internally-deposited isotopes, instrumentation, brachytherapy devices, and thyroid uptake calibration, while at California the stress was on the use of the X-rays from a 70 MeV electron synchrotron.

Out of this work has grown a vaster programme of research, and studies now include the use of ruthenium-106 and rhodium-106 for the alleviation of gastric malignancy; the study of carcinogenesis, involving the formation of bone tumours after injection of bone seekers, lung cancer by inhaled and deposited isotopes, use of P-32 for the diagnosis of eye cancers, I-131 for brain tumours including glioblastomas, studies of blood formation and circulation, blood diseases such as leukaemia and anaemia.

Allied to this work are the studies on polycythaemia vera and pernicious anaemia with the aid of radioactive vitamin B12, iron metabolism, the blood-forming hormone, life of cells, the physiology of blood circulation, bone marrow, the transplantation of bone marrow for the recovery of patients after severe trauma or irradiation, clotting of blood, bone research and radioactivity deposition, bone grafting, skeletal metabolism, and the study of radioactive drugs such as digitoxin, colchicine, p-aminosalicylic acid, morphine and reserpine, and liver function.

Requirements of Reactor

This tremendous field of study is the backcloth against which we have to study the development of research reactors. What is required of such a tool? Firstly, the reactor must be of such design that it can readily be applied to the fundamental tasks of research, diagnosis, therapy, and isotope production. It must be usable by medical men, under the supervision of nuclear experts, without hazard. There must be attached to the reactor building, though amply shielded from radiation dangers, a treatment room in which patients may be placed without making them feel that they are in anything other then the ordinary hospital ward or therapy room. It must be possible for the reactor to be used continuously for clinical treatments without the necessity for interruption because scientific experiments have to be done.



Relationship of medical treatment room to reactor — an artist's impression

The reactor must have a very high flux, so that short period irradiation of materials will yield highly radioactive products, and so that short-lived isotopes may be made and used at once, or with very short storage time. High fluxes will also be required for the many investigations which such a reactor will certainly prompt. It must be admitted that all these criteria were not met in the early medical reactors, but the later ones have been designed with such ends in view.

First N-Medical Centre

The first of the American nuclear medical centres was that at the University of California School of Medicine, Los Angeles. This centre has a special reactor the radiations from which are used for cancer research and therapy. This was the first centre, in fact, to have a reactor specially designed for medical work. Its neutrons and gamma rays, under perfect control, can be used for the irradiation of tumours and cancers, the gamma rays being very penetrating.

One valuable use of the neutrons is the brain tumour treatment. The patient is given an injection of some boron compound, which becomes selectively concentrated in the brain tumour. On exposure of the patient's head to a thermal neutron beam from the reactor, the boron absorbs these neutrons by the reaction: $^{10}_{5}B + ^{1}_{0}n = ^{7}_{3}Li + ^{4}_{2}He$. The alpha-particles thus produced have great ionizing power and destroy the malignant cells in the tumour. However, since their path terminates after only about 36 microns, they do no damage outside the actual defective tissue.

Solution Type Fuel

The patient lies in a small room in the wall of which is a small port through which the neutron beam emerges from the reactor. The walls of the room, consisting of concrete and graphite, give ample protection to the patient and nursing staff against extraneous radiations.

The reactor is of the homogeneous type, containing 4 gal of uranyl sulphate solution, highly enriched in U-235, and contained in a stainless steel sphere. This reactor was built by Atomics International, a division

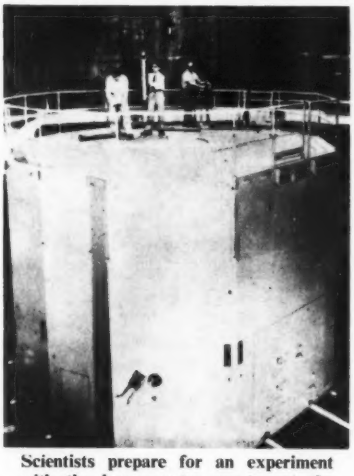
of North American Aviation. Although normally operating at 5 kW output, it is capable of 50 kW.

Although the Californian reactor was the first specially designed for medical work, a reactor at the Bethesda Naval Medical Centre, Washington, DC, has been used for medical studies since November, 1957. This small reactor, used mainly for the making of radio-isotopes for the Naval Medical Centre, and for radioactivation analysis, is a 5w version of the portable AGN 201 reactor made by Aerojet-General Nucleonics, of California. This reactor, like all those of the AGN 201 type, is organic moderated.

It operates on enriched uranium, the U-235 being in the form of uranium dioxide at 20 per cent. enrichment, the particles being incorporated into stabilized polythene which acts as the moderator. It has shields of graphite, boron, lead and water. The reactor is only 9 ft high and 7 ft in diameter. Its chief advantages are the complete safety, lightness and portability, and high neutron flux. It produces no fission product effluents, and so is ideally suitable for medical use.

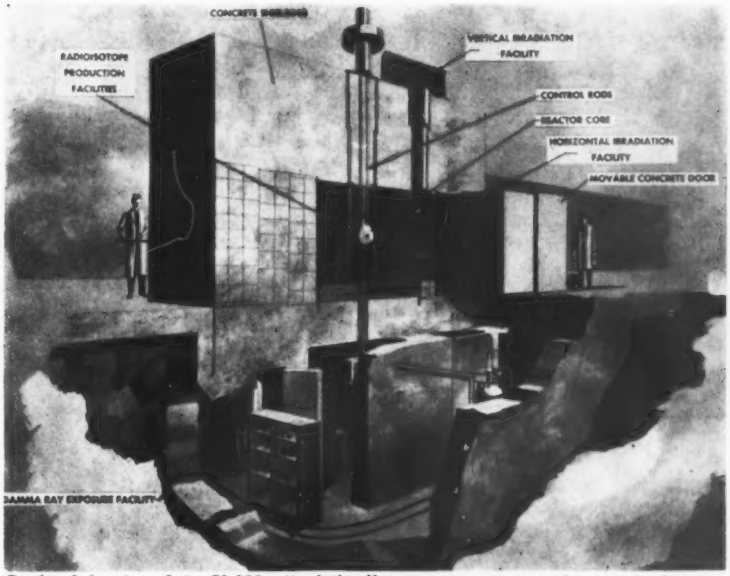
Massachusetts Unit

Since July, 1958, the Massachusetts Institute of Technology has been operating a medical reactor, working



Scientists prepare for an experiment with the heavy water reactor at the Massachusetts Institute of Technology

on uranium enriched to 90 per cent. U-235, and moderated with heavy water. Since there must always be some "first" claim as a label, this reactor can be described as "the first reactor to have a medical treatment room immediately below the radiation source." This, in fact, is one of the striking features.



Sectional drawing of the 50,000w "solution" type reactor designed by Atomics International, a Division of North American Aviation, Inc., for the Walter Reed Army Medical Centre, Washington. Reactors of the same design have been supplied to the Armour Research Foundation, Chicago, the Japanese Atomic Energy Commission, Frankfurt University, and the West Berlin Nuclear Research Institute

The reactor is based on the Argonne Laboratory's CP-5, and its aluminium core tank, 7 ft high and 4 ft in diameter, is filled with heavy water circulated by a pump in the basement, and under a blanket of helium. Into this dip the 19 fuel elements, consisting of thin sheets of U-235/aluminium alloy with a thin skin of aluminium. The heavy water coolant and moderator leave the core at 104°F. As shielding there is a 2 ft wall of graphite, through which thermal neutrons pass to the special ports. Outside this is a wall of dense concrete, and then the whole installation is housed in a gas-tight steel building, 70 ft in diameter and 50 ft high standing on a concrete pad. The neutron beam passes through a port which has a special shutter. There are also other shutters and ports for the experimental facilities. On one side is the thermal column. There is a balcony running around the building, and this is used for experimental purposes.

Entry to the reactor building is through a pair of gas-tight doors which are interlocked. There is also an overhead crane capable of lifting 20 tons, and this is used for lifting the transfer flask used for placing the spent fuel elements into the storage facility, where their gamma radiations may still be utilized. This very versatile reactor has 40 experimental facilities, all of which can be used simultaneously. It can be used for treatment of brain tumours by the boron method described above, and also for the production of short-lived isotopes. The Rockefeller Foundation contributed $250,000 towards the cost of this installation.

For Army Medicos

The Walter Reed Army Medical Centre, near Washington, DC, has a 50 kW solution type reactor which is used for work on cancer and biological research. It produces gamma rays, neutron beams and isotopes. It is essentially similar to the reactors installed at the Armour Research Foundation, Chicago, the Japanese Atomic Energy Commission, Tokyo, the University of Frankfurt, Germany, and the Nuclear Research Institute of West Berlin, and was made by Atomics International, of California.

The 7 gal core occupies a stainless steel sphere, 16 in. in diameter and placed inside a stack of graphite "legs," forming a block 8 ft × 5 ft × 5 ft, and then surrounded by 5 ft thickness of dense concrete. Control is by means of boron carbide rods. There are two irradiation channels, one from the top downwards, and the other horizontally from one side. It is also possible to irradiate objects very close to the core in a high flux.

In addition, there are several other irradiation facilities. Below the reactor, there is an experimental area with a high gamma flux, free from neutrons. The reactor is self-contained and gives rise to no waste disposal problems. This type of reactor, comparatively inexpensive, mobile, inherently safe, and with many experimental facilities, is in many ways ideal for medical work, but of course, cannot be used for direct neutron therapy, for which special designs are required.

At Knoxville, Tennessee, a large hospital specializes in the use of isotopes, X-rays, and radiation research.

A Nuclear Hospital

What might at first sight appear the very last word in medical facilities, and with its own reactor, is the splendid centre at the Brookhaven National Laboratory, Upton, New York. Here a reactor has been installed, with brain tumour treatment as its main function. This medical centre was opened in December, 1958. It has five basic sectors—research laboratories arranged in a very flexible way, a section for medical physics, and others for physiology, microbiology, and pathology. It is essentially a research hospital, with four 12-bed nursing units, together with facilities for occupational and physical therapy.

The 115-bed Brookhaven Centre normally treats only incurable cases, and since most of these are cancer sufferers the reactor installation offers new hope to many. In fact, with the modern treatment 80 per cent. of patients have shown improvement. The need for a more fundamental knowledge of the cause and progress of many diseases is the reason for making this research hospital available. Here is being studied the distribution of water in the human body, the phenomena of oedema, the swelling that is found both in ovarian cancer in women and in nephrosis in children.

Some of the Studies

Work is in progress on the elements present in various fluids and organs, and the efficiency of ion movement through capillaries, and the use of radio-sodium for studying the regulation of sodium balance and blood pressure in hypertension. Also studied are protein build-up and the metabolism of amino-acids and proteins. Normal and cancer cells are examined, as well as their behaviour under irradiation.

Already the staff have identified tissues which produce antibodies, and gamma rays are being used to deprive mice of the ability to manufacture antibodies against tetanus antitoxin. Tissues of spleen and lymph nodes of other mice are transplanted into the eyes of these mice, which will thus gain supplies of antibodies.

Gamma rays are also used to study the immunity of mice to parasites such as the *trichinella spiralis* which sometimes infests pork. Work is also being done on internal radioactive isotopes. This necessitates isotopes of such short half-life that it is imperative that they be prepared on the spot, and this is one of the ways in which the special medical reactor comes into its own.

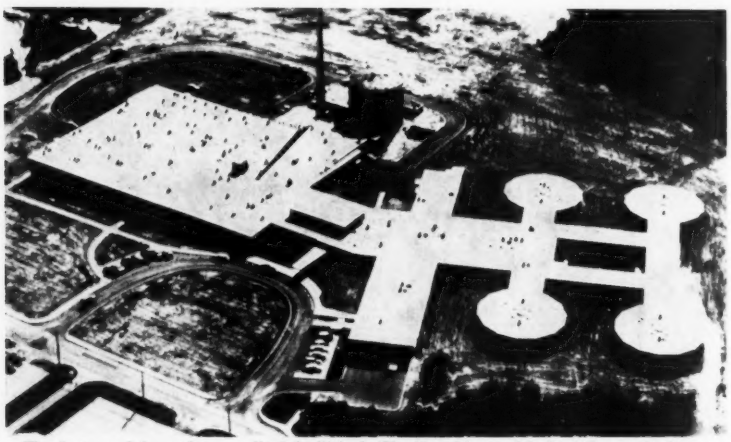
Much effort has gone into studies of selective kinetics, which will govern the degree to which isotopes can be brought to bear upon a certain target in the body. When an isotope is injected into the body, the primary distribution into the organs occurs at various speeds. Later comes the secondary distribution, in which the isotope finds its way into the various organs in a more uniform way. This type of distribution is predominant after a few hours. If the isotope used has a half-life which allows it to decay to a harmless stable nuclide in a time less than the interval during which the primary distribution is predominant, then radiation can be delivered chiefly to organs concerned in this first phase, other organs receiving much less radiation. This is vitally important in the delivery of radiation to specific organs for therapy purposes.

Need for Special Unit

This important work has been going on since 1951, but only with the aid of a general purpose reactor. This means that when the reactor was required for research work, it could not be made available for treatment. This has been rectified by the special reactor with which the new Centre is provided.

The 1 MW reactor has a core of the MTR type, cooled with water, and with a graphite reflector. The fuel is enriched uranium, with water as moderator, and the neutron beam is 50 times as powerful as that of the older general purposes reactor. The core tank is of aluminium, and 2 ft in diameter. About 96 per cent. of the heat output comes from the core, and about 10 per cent. from the reflector. In two opposite faces are ports for neutron beams, one being used for the irradiation of experimental animals, the other for treatment of human patients. In the latter case, the neutron beam is taken through a special port into the room in which brain tumours may be treated by boron method described already.

Each neutron beam can be cut off in 3 sec by a shutter weighing 21 tons. The thermal neutron flux available is from 10^{10} to 10^{11}/sq.cm/sec at the patient's head. There are experimental holes in the carbon reflector and shutters in the shield.



The last word in nuclear medical facilities? The Brookhaven Medical Research Centre, Upton, New York. Equipped with a 1 MW MTR type reactor, the centre is designed for carrying out research and developments leading to a better understanding of the cause and progress of many diseases

The third face can be used for the irradiation of large objects, while the fourth face has tubes leading into the core, for the irradiation of materials for the preparation of short-lived isotopes, and the flux available for this purpose is 10^{13}/sq.cm/sec. The various absorbers and converters make possible various types of radiations of selected energy ranges.

Large colonies of mice are given brain tumours, and can then be submitted to irradiation. This is done largely to determine what particular boron compounds may best be used for selective absorption in the tumours, and which respond best to the irradiation.

Staffing of the Centre

The staff comprises 150 persons, including cancer experts, scientists, nurses, laboratory assistants and technicians. Each of the nursing wings contains 12 single bedrooms radially disposed around the nurse's station, so that each patient is under direct observation, and the nurse can reach all of them without delay. The floor area is 118,000 sq.ft, with an additional 22,000 sq.ft in the basement, and all the buildings are single-storeyed. The reactor building is of steel, and 60 ft in diameter and 54 ft in height. The Brookhaven Centre was constructed by the USAEC, and is operated by the Associated Universities, Incorporated.

Near Oak Ridge

Much smaller, but still large enough to carry out important and valuable work, is the Memorial Research Centre and Hospital, near Oak Ridge. Its proximity to the latter establishment means that short-lived radio-isotopes can be made at Oak Ridge and used in the hospital. The latter is a six-storey building and cost about $6m. It has research laboratories as well as a full treatment centre.

The hospital section occupies a floor area of 12,000 sq.ft, and the clinical laboratories cover another 8,000 sq.ft. Because of the rather high radiation density in some of the sections, the whole establishment in which radioactivity is used is provided with lead shielding from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. thick, this shielding forming part of the walls of the research laboratories.

Mention should finally be made of the device known as the Roentgen pump. In this, an aluminium salt solution is circulated in tubes through a reactor. In the latter, the aluminium atoms are converted by the usual (n:gamma) reaction into radioactive Al28 atoms, which are emitters of 2.8 MeV gamma rays, with a half-life of 2.4 min. This means that when the aluminium solution is circulated out of the reactor, there become available for therapy and research work powerful gamma rays, equivalent to a radiation dose of 10^3rev/min. These rays may also be used for diagnosis and for sterilization. This survey of the various medical reactors, and of the types of research and therapy work for which they are used cannot claim to be exhaustive, since it has not dealt with medical reactors in countries other than the U.S.A. It does indicate, however, the wide benefits and possibilities awaiting those who, with foresight and determination, aspire to utilize the atomic nucleus for the curing of the many ills to which the flesh of man is prone.

The Argonne Cancer Research Hospital, situated on the campus of Chicago University. Studies are made here in the use of radioisotopes for medical purposes. Between 180,000 and 200,000 patients are treated here a year

Trade Literature

Welded Aluminium Components for Nuclear Reactors is a 10-page booklet describing the facilities offered by AB Svenska Metallverken, of Skultuna, Sweden, for fabricating and installing the components referred to in the title. An outline of work carried out for particular reactor projects is given, followed by a brief description of the company's testing and control departments. Mention is then made of the application of welded aluminium in other fields.

A Career in EMI Electronics is a 32-page booklet outlining the scope of the work undertaken by Electric and Musical Industries Ltd., and describing the various apprenticeships and courses and scholarships that are made available by the company. It is lavishly illustrated and is bound in a colourful plastic coated cover to withstand hard wear.

Plant and equipment in which Rocol Molybdenized Lubricants have been used are featured in **Rocol—First in molybdenum disulphide lubrication,** a booklet published by Rocol Ltd., to celebrate their achievements over the past five years. A short introduction describes how molybdenum disulphide is made and used and what are its most useful properties.

English Electric Valve Co., Ltd., have published a quick reference brochure giving abridged data on their valves. There are 12 main categories of equipment, each category being readily available by means of a thumb index. There is also a section which lists valves of various makes for which EEV valves may be used as replacements.

Some of the achievements of the British electronic equipment manufacturers are featured in the **Annual Review, 1959, of the Electronic Engineering Association.** Gross output of the British electronics industry approached £475m. during the year, the Review reports, and it employed some 350,000 people. Highlights of the review include outstanding export orders.

The 1960 Catalogue of Chemicals and Reagents available from Hopkins & Williams Ltd., contains some new features which make it easier for the user to locate required information. British Standards Institution nomenclature has been used throughout. Renamed chemicals appear under their old titles with appropriate cross references. Technical data on the products are given in a series of appendices arranged according to the classification of the products.

INSTITUTION OF NUCLEAR ENGINEERS

"ON WAY TO THOUSAND MEMBERS"

THE last Council Meeting of the season was held at Caxton Hall, Westminster, on Friday, April 8th, when an opportunity was taken to review the work of the Institution so far. Sir John M. Duncanson, the president, surveyed the steady progress that the Institution was making and pointed out they were now well on the way to having their first 1,000 members.

Almost that number of people had applied for membership or asked for details of membership. Two hundred of the applicants did not measure up to the high standard that had been set by the Examination Committee and could not be admitted. It was agreed that the present standards would be adhered to until the Committee could formulate its own examinations. It is hoped to do this early next year.

To Cater for All

While it is realized that anyone who does not have the necessary technical qualifications has no means of entry to the Institution, nevertheless all should be catered for when the Institution becomes an examining body. It was made clear that anyone who is rejected for the active membership can state in his application that if no suitable technical grade is available to him he may be elected an Associate of the Institution, and thus keep a close connection till such times as he can take the prescribed entrance examination.

Sir John M. Duncanson, president, arrives at Caxton Hall for the Council Meeting

Council Nomination

The president nominated Dr. W. J. Jenkins to fill the vacancy on the Council created by the death of Professor Skinner. This was unanimously supported and it was agreed that an invitation be sent to Dr. Jenkins asking him to serve.

The first dinner of the Institution will be held on Monday, October 3rd, at the Savoy Hotel, London, at 6.30 for 7 p.m. when it is hoped that a Minister of the Crown will be the guest speaker.

This dinner promises to be a spectacular affair judging by the interest shown by members and others. There have been almost twice as many suggestions from members for such a dinner than for any other suggestion put forward. There is a distinguished list of guests representing almost every country in which the Institution has members overseas. Members will be circulated when details have been compiled.

Teachers Contacted

The secretary reported that, as instructed, some 300 teachers and lecturers in nuclear physics had been written to as follows:—"The Council feel that there must be many special teaching methods for students—simple practical apparatus for demonstrating various technical points during lectures. The Council would like to have details of such apparatus or methods, so that these can be listed and gathered together for the benefit of all who lecture in nuclear physics. Would you please advise the secretary if you know of anything that would be useful in this."

U.S. Television Teaching

One such method already submitted is the "Continental Classroom" which is rapidly gaining in popularity in the United States. These are television lectures starting 1 hr before the normal television programmes. Lectures are recorded and it is estimated that almost 1,500 professors would be required to give those lectures in as many centres covered by the transmission and many students have made much more rapid progress through watching those lectures.

Professor Starr is reported as saying that already some of his students in the night classes are doing better than many regular day students. He particularly praises television for its ability to present special demonstrations. Chemical reactions, he states, are sometimes subtle and undramatic. The television camera's ability to make these visible through extra close-ups is an added advantage over regular classwork.

The secretary also reported that a simple slide rule for ratio physics had been reported by one lecturer and that further details had been requested.

If a sufficient number of real practical ideas can be obtained it is hoped to publish details in the Year Book or separately. The suggestions will then be of use to all who lecture in this field from university professors to managers in works of companies who specialize in nuclear energy engineering.

Token of Membership

The question of an interim certificate of membership was discussed. It is felt that many of our members,

especially the younger ones would like a certificate of membership. Many suggestions have been made as to the design of such a certificate for associate members and junior members. The secretary was instructed to draft a simple version of the original design which would be suitable pending the die stamped engraving which will not be available till 1963.

Forty Applicants

The Examination Committee dealt with 40 applications for membership. It was reported that the new membership form would seem to be of considerable help to potential members, for only one out of the 40 applicants was requested to furnish further details. Where applications are made on the old original forms, the form must be signed by the applicant, but if there is any doubt please apply direct for the revised application form. The naming of a referee on the form is also a help in expediting the examination of the applicant, but members should understand that some time must elapse between the application and the announcement of the grade allocated.

Council has Vacancies

The Council discussed the enlarging of this body for 1961. Now that most of the groundwork had been done it was felt that while the executive officers had agreed to serve for the first three years an additional junior vice-president should be appointed. This would leave four vacancies on the Council as well as one for a further member to replace one vacancy not taken up.

The First Annual Dinner of the Institution will be held at the Savoy Hotel, London, on October 3rd, at 6.30 p.m, for 7 p.m.

The secretary was requested to circulate the members before the first autumn meeting for names of those willing to serve on the 1961 Council. This would be done at the same time as the official notification of the first annual dinner. If it should be necessary to take a ballot, this could be done in September so that the new members of Council could be announced in December and would be available for service in January, 1961.

Board of Trade Approval

The Institution's Solicitor reported that the Memorandum and Articles of Association of the Institution had been approved by and lodged with the Board of Trade.

The president thanked all those members of the Council who had worked so hard in this initial stage of the formation and said that we were very fortunate in having such a band of enthusiastic workers.

He said that judging by the correspondence he received and reading through the secretary's files he could say with confidence that no Institution, however old or however great, could show such progress in the first four months of its life. We had now powerful and enthusiastic champions in almost every country in the world, and he looked forward with pleasure to meeting many of the members at the first dinner at the Savoy on October 3rd.

NEW MEMBERS

Cdr. D. L. Alexander, M
Greenwich, S.E.11.

R. Aylward, A
Langley, Bucks.

R. A. Belliss, A
Allestree, Derby.

B. C. Bridges, A
Berkeley, Gloucestershire.

Air Cdre. M
Sir Vernon Brown,
Lordon, S.W.1.

G. D. Brown, A
Baughurst, Basingstoke.

Lt.-Cdr. T. Carter, A
Beckenham, Kent.

Lt. I. Cochrane, A
Greenwich, London.

W. Cooper, M
Birmingham.

J. D. Cook, A
Merryhill, Wolverhampton.

P. W. Cox, A
Allestree, Derby.

B. F. Evans, A
Mickleover, Derby.

P. J. Fulford, A
Manitoba, Canada.

D. M. Groves, A
Teddington, Middx.

Cdr. J. C. Hallifax, M
Ashtead, Surrey.

Henry Albert Hahn, M
Streatham Hill, S.W.2.

D. M. Hamilton, M
Motherwell, Lanarkshire.

H. J. Hawkins, JM
Castle Bromwich,
Warwickshire.

D. H. Hill, M
Belgium.

K. J. Henry, M
Chilton, Berks.

W. R. Hobbs, M
Abingdon, Berks.

M. P. Levey, A
Woodley, Berks.

Lt.-Cdr. C. C. Loxton, A
Greenwich, London.

J. M. Morrison, M
Chaddleworth,
Nr. Newbury.

J. K. McClellan, A
Whitehaven, Cumberland.

G. G. McMillan, A
Whitehaven, Cumberland.

A. Mangham, A
Poole, Dorset.

A. R. Marrow, M
Mickleover, Derby.

P. B. Mason, A
Mill Hill, London.

D. C. Paterson, M
Strand, London.

T. M. Raven, JM
Castle Bromwich,
Warwickshire

R. F. Redman, A
Darley Abbey, Derby.

D. H. Scott, A
Berkhamsted, Herts.

S. Smith, M
Surbiton, Surrey.

Lieut. K. P. I. Timmis, A
Fareham, Hants.

A. J. Walker, A
Eltham, London

Alfred W. Whalley, M
Manchester.

L. W. Youdell, A
Abingdon, Berks.

RADIATION PROTECTION

New approach to measurements needed

THE U.S. National Bureau of Standards has recently completed an investigation of the attenuation of gamma radiation incident obliquely on barriers of lead, concrete, and concrete-equivalent material. This study, sponsored by the U.S. Atomic Energy Commission, was conducted by F. S. Kirn, R. J. Kennedy, and H. O. Wyckoff of the Bureau staff. The results indicate that considerable error may be involved in some estimates of protective barrier thickness necessary to produce a specified attenuation. Estimates based on attentuation data for normally incident radiation were found to be several half-value layers low for obliquely incident radiation of the same energy.

The high cost and heavy weight of barriers required for protection against high-energy X- or gamma radiations warrant a detailed study of the factors involved in obtaining an economical solution to the protection problem. The Bureau has for several years conducted research on radiation protection design, yet, until now no detailed experimental or theoretical evaluation has been made of the attenuation of radiation obliquely incident on radiation barriers.

When radiation is directed at a barrier, the attenuation is usually assumed to be related to the barrier thickness traversed by the unscattered portion of the beam, regardless of the incident angle of the radiation. This assumption, however, may lead to a significant underestimate of the barrier thickness required to produce a specified attenuation.

Scattered Radiation

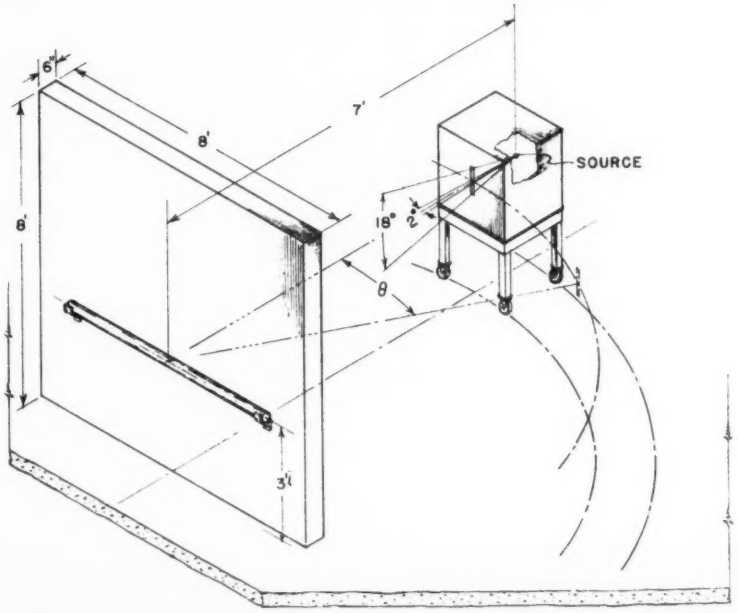
In most protection problems scattered radiation makes an important contribution to the transmission of the barrier. When radiation is normally incident, the scattered radiation which emerges from the barrier must always travel a greater distance within the barrier than that travelled by the unscattered radiation. In oblique incidence, however, some of the scattered radiation travels a much shorter distance within the barrier than the unscattered radiation. As a result, in oblique incidence the scattered radiation may become the predominant component of the total radiation transmitted by the barrier.

The present study was initiated primarily to determine the dependence of this "obliquity effect" on variations in (1) incident photon energy, (2) angle of incidence, and (3) barrier material for an initially parallel beam of radiation. Gamma radiation from cobalt-60, caesium-137, and gold-198 was used at incidence angles of 0°, 30°, 50°, 60° and 70°.

The Test Layout

The source of gamma radiation was placed at the end of a lead collimator whose opening was approximately 16 in. long, 8 in. high, and 0.25 in. to 0.5 in. wide. The distance from the gamma source to the radiation detector was 7 ft. This distance and the collimator dimensions defined a beam 40 in. high and about $2\frac{1}{2}$ in. wide at the detector. With this arrangement the dose rate in a vertical plane containing the detector was constant to within 3 per cent. in the vertical direction and to within 2 per cent. over the width of the beam. The entire collimator and source were placed on a rolling table which could be rotated at a fixed radius about an axis through the centre of the detector. The absorber material was placed between the gamma source and the detector.

The detector was a specially constructed ionization chamber with a sensitive length of about 70 in. It was made from a $\frac{1}{8}$ in. wall tube with an outside diameter of $1\frac{1}{2}$ in. The inner surface was coated with a conducting layer of colloidal graphite. The centre electrode was an aluminium wire, also coated with graphite, supported at both ends with electrostatically shielded amber insulators. An ion collecting potential of 180v was sufficient for saturation. Ionization chambers of this



Schematic drawing of experimental arrangement used in the study of oblique-incidence gamma-ray attenuation by the U.S. National Bureau of Standards

general type have a calibration that is independent of photon energy within 10 per cent. for energies down to 150 keV.

The ionization current was measured by a vibrating reed electrometer used as a null indicator and a portable potentiometer used to supply the bucking voltage. Calibrated resistors and capacitors were employed to give an adequate range of sensitivity.

The detector length required to obtain essentially all of the scattered radiation was determined by an auxiliary experiment. The readings of a small ionization chamber were obtained as a function of its position along the barrier. The readings indicated that nearly all the transmitted radiation is collected within a distance of 50 in.

Readings were taken for lead, concrete, and polyethylene absorbers. Composite barriers of lead and concrete or of lead and polyethylene were studied to determine the effects of combining these materials. In one case barriers af aluminium and steel were investigated.

Comparisons Made

The observed dose rates for oblique incidence were compared with the rates expected on the basis of normal incidence data for a barrier thickness equal to the oblique path length or "slant thickness." These comparisons indicate the error in dose rate that would be introduced by applying the curves for normal incidence to the oblique ray path. Table I illustrates the magnitude of the errors for the two most popular barrier materials, concrete and lead. Table II indicates the barrier thickness required for desired attenuations, both according to actual observation and according to the approximate method, for several energies of incident gamma rays.

In the energy range studied, it appears from these comparisons that the expected error is greatest for the lowest energy used here (0.411 MeV) with low atomic number barriers and decreases with energy increase. For high atomic number material the error is smaller, and the error-energy relationship is reversed. Spot checks indicated that the obliquity effect is somewhat smaller with conical beams of radiation.

From the results of this continuing, study, it is obvious that an additional factor must be considered in any plan for construction of radiation protection barriers. Where the primary beam is directed obliquely at a barrier, the expected angles of beam incidence must be given proper evaluation in the construction plans.

Table I—Dose rate (Observed):—Dose rate (Estimated)*

Per cent. Transmission Estimated	50°		60°		70°	
	Concrete	Lead	Concrete	Lead	Concrete	Lead
			(0.411 MeV)			
10	1.1		1.2		1.2	1.0
1.0	2.0		2.7		4.0	1.0
0.1	3.7		7.0		15	1.5
			Caesium-137 (0.661 MeV)			
10	1.2	1.0	1.2	1.0	1.3	1.1
1.0	1.7	1.1	2.5	1.3	3.7	1.6
0.1	2.3	(1.2)	5.2	(1.7)	10.1	(2.4)
			Cobalt-60 (1.33 and 1.17 MeV)			
10	1.0	1.0	1.0	1.0	1.2	1.1
1.0	1.4	1.1	1.9	1.3	2.5	1.6
0.1	(2.0)	(1.3)	(3.5)	(1.9)	(5.6)	(2.8)

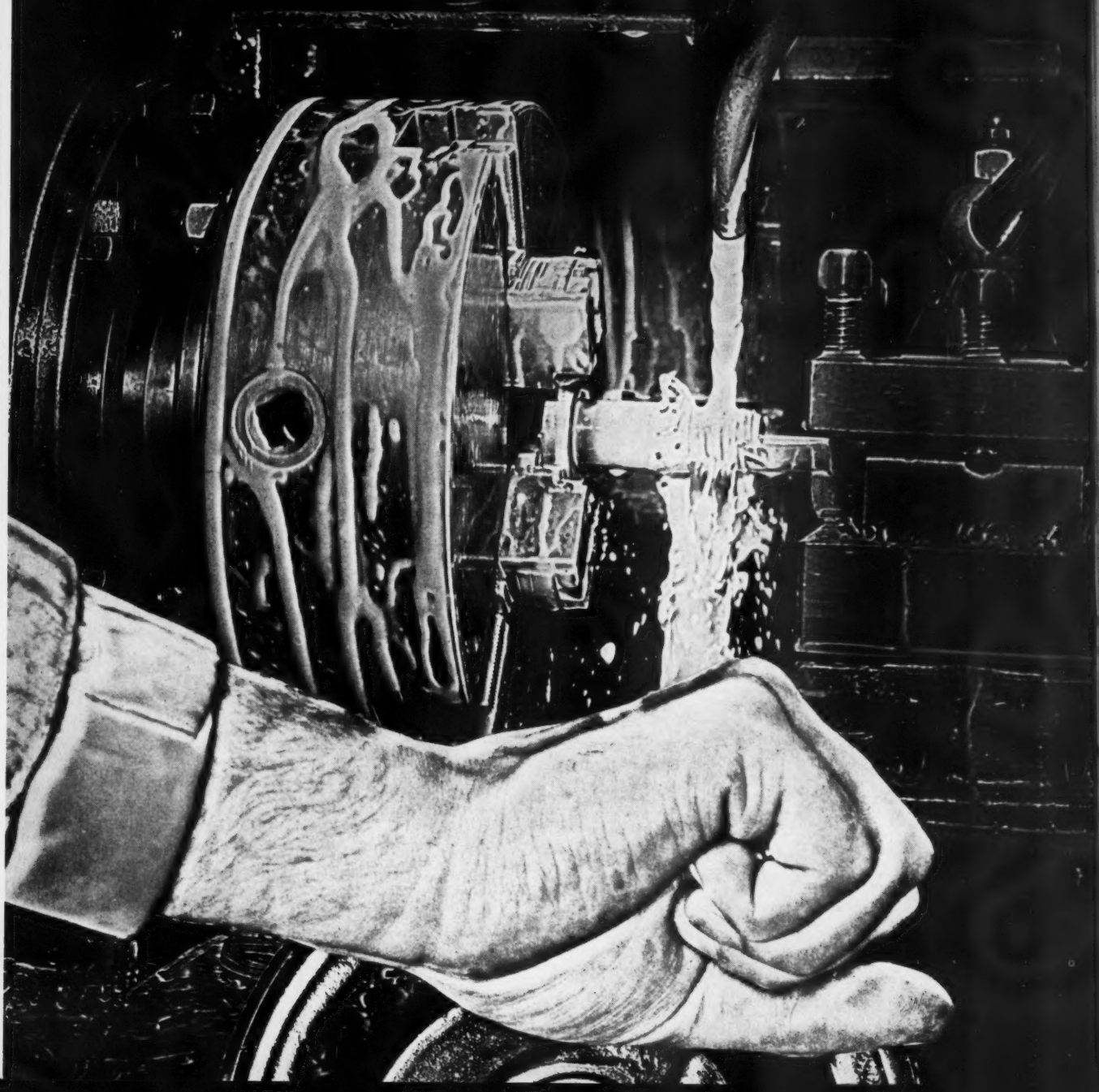
*This is the ratio of the dose rate as measured experimentally for oblique angles to that which is determined from normal incidence attenuation data for thickness of barrier equal to the slant thickness in the oblique barrier. Values in parentheses are obtained by linear extrapolation of curves.

Table II—Comparison of Barrier Thickness for a Desired Attenuation Determined from Estimated and Experimental Data*

Per cent. Transmission	50°				60°				70°			
	Concrete (in.)		Lead (cm)		Concrete (in.)		Lead (cm)		Concrete (in.)		Lead (cm)	
	Est.	Exp.	Est.	Exp	Est.	Exp.	Est.	Exp.	Est.	Exp.	Est.	Exp.
					0.411 MeV							
10	4.4	4.8			3.4	3.9			2.3	2.7	0.34	
1.0	7.8	9.1			6.1	7.9			4.1	6.6	0.72	0.6
0.1	11.1	13.6			8.7	12.2			5.9	10.8	1.1	1.2
					Caesium-137							
10	4.7	5.0	1.5	1.5	3.9	4.2	1.1	1.1	2.7	3.1	0.8	0.8
1.0	9.2	10.2	2.8	2.8	7.1	9.0	2.1	2.3	4.9	7.4	1.5	1.6
0.1	13.3	15.0	4.1	(4.1)	10.3	13.8	3.2	(3.4)	7.1	11.6	2.2	(2.5)
					Cobalt-60							
10	6.7	6.6	2.7	2.7	5.2	5.3	2.1	2.1	3.6	3.9	1.5	1.5
1.0	12.0	12.9	5.3	5.4	9.1	10.9	4.1	4.4	6.4	8.1	2.8	3.2
0.1	17.3	(19.2)	7.8	(8.1)	13.5	(16.4)	6.1	(6.7)	9.2	(12.4)	4.2	(5.0)

*The estimated data were obtained from the experimentally determined attenuation with normally incident radiation and for a barrier thickness equal to the slant thickness in the oblique barrier. The experimental data were obtained for radiation incident obliquely on the barrier. Values in parentheses were obtained by linear extrapolation of curves.

Greater safety for hands



With new Shell Dromus Oils

Most modern soluble cutting oils contain phenolic compounds used as coupling agents between the oil and the emulsifier, for better blending and easier mixing. These phenolic compounds can cause skin irritation, especially where modern high-speed machines are used and the emulsion can concentrate, through the evaporation of water, above the safety level.

Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant.

The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

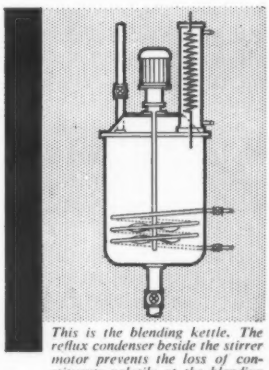
The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organization have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

Exhaustive testing of blend stability, emulsion stability, anti-corrosion and machining properties led to selection of the most promising blends. A pilot plant was set up to produce batches of these for use in field trials.

This field testing and final development proceeded for two years whilst production plants were erected at points so chosen as to give the most economical and rapid delivery throughout the United Kingdom.



This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

NEW SHELL DROMUS SOLUBLE CUTTING OILS

another proof of Shell leadership in lubrication

Nuclear Training in France

by a Correspondent

WORK OF THE I.N.S.T.N.

Students from all nationalities attend the courses of the National Institute for Nuclear Science and Technology, Saclay

LIKE the United Kingdom, France has been obliged, as a result of the precarious fuel situation, to forge ahead with a great programme of nuclear power development, without either the financial resources or the more leisurely tempo which apply in the U.S.A. Such a programme requires raw materials, equipment, and trained personnel. France has been fortunate in being self-sufficient in such strategic materials as uranium and graphite. Imports of heavy water were necessary for research reactors, but even this commodity will soon be completely home-produced. The thriving and excellent engineering industry was able to cope with the supply of equipment, and the electronic requirements have given rise to a healthy new industry.

Eminent Pioneers

What of the third problem, that of manpower? With such a tradition of pioneers whose work contributed so vitally to the development of atomic science, names such as Becquerel, the Curies, the Joliot-Curies, Halban, and Kowarski, France could hardly be deficient in innate talent. The specialized training of large numbers of scientists was a major undertaking, but one which has been tackled with boldness and imagination.

Having recently spent two weeks at Saclay, I was able to make myself informed of the way in which French authorities organized such specialist education, and I came away with admiration for the very thorough and comprehensive system.

Need for Central Training

Shortly after the formation of the Commissariat d' Energie Atomique in 1945, a close liaison between this body, the universities, and industry became effective. The Universities, Grandes Ecoles, and Ecoles Techniques imparted the basic science so indispensable to subsequent nuclear specialization. Further training required familiarity with major and expensive equipment such as reactors, accelerators, and electronic apparatus. This need could best be met by a central training establishment.

Similar to Harwell

On June 18th, 1956, a decree was signed by the president of the Council of Ministers, the Minister of National Education, and the Secretary of State, authorizing the establishment of the Institut National des Sciences et Techniques Nucléaires. INSTN is housed at Saclay, the second and largest of France's nuclear research centres. This idea finds a close parallel in the United Kingdom, where the AERE, Harwell, has its Isotopes School and Reactor School. Like the latter schools, INSTN threw open its courses to students of universities, industrial firms, and even to people from overseas.

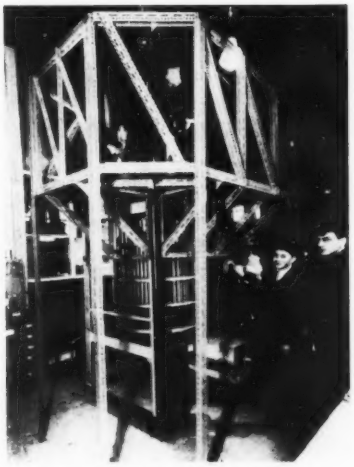
The aims of INSTN are to ensure highly specialized training for nuclear scientists and engineers, in close association with the universities; to maintain collaboration between the faculties of science, medicine, pharmacy, and engineering and the CEA; to facilitate relationships between industrial organizations and the research bodies.

Particularly impressive is the broad scope, yet thoroughness, of the training given at INSTN, which includes courses in nuclear engineering, metallurgy, theory and practice of accelerators, fluid flow, physics of particles

Our correspondent, who himself attended a course at the National Institute for Nuclear Science and Technology, records his impressions of the training and equipment provided there. Courses available range in length from two weeks to two years. Oversea students are accepted for most courses. Full details can be obtained from the National Institute for Nuclear Science and Technology, Centre d'etudes Nucleaires, P.B. No. 6, Gif-sur-Yvette (S.O.), France. Other courses in this country are available at the universities of Aix-Marseille, Bordeaux, Caen (Corpuscular Physics Laboratory), Clermont, Grenoble (Institute of Technology—Atomic Energy Section), Lyons (Institute of Nuclear Physics), Paris (Radium Institute), Poitiers, Strasbourg and Toulouse. Courses are also provided by the Ecole Nationale Superieure d'Electricite et de Mecanique and the Ecole Nationale Superieure des Industries Chimiques, both at Nancy

and high energy reactions, radiobiology, and the use of radioelements. The engineering course aims at specialist training in the construction and operation of reactors. It lasts normally for a year, and includes practical and theory work, a period of service with the CEA, and group projects. This course is open to qualified engineers in industry, and leads to a diploma in nuclear engineering, recognized by the Ministry of National Education. Science graduates may also participate in this course, but the certificate received upon successful completion of the course is a modified one in their case.

There are also several courses falling into the category of " cours du troisième cycle," designed for persons with a certificate of higher



The INSTN sub-critical assembly

education from a science faculty, with a view to the " doctorat." The first of these courses, in special metallurgy, deals with the treatment, properties and uses of all metals and high purity alloys used in reactor work, such as uranium, plutonium, zirconium, hafnium, and beryllium.

Accelerator Training

For training physicists destined to study and build the large machinery of nuclear physics, and for those who will operate them, there are courses in the theory and technology of accelerators. This includes electromagnetism, relativistic mechanics, corpuscular optics, plasmas and gaseous discharge, vacuum technology and accelerators. Each of these two courses occupies two years. During the second year the student prepares a thesis which is assessed by the members of INSTN and the universities.

For the Thermodynamist

A course in the thermal and mechanical features of fluid flow in nuclear reactors is available for those who intend to specialize in heat exchange problems or reactor thermodynamics. It covers in a broad way the general principles of heat, and in a more specialized way the problems of heat exchange between solids and liquids, and the applications of this to reactor operations. Again, this course occupies two years, and in the second year the student prepares a report for assessment.

A further course, dealing with the physics of fundamental particles and the interactions of high energy particles, covers such topics as solid physics, theoretical physics, quantum mechanics, magnetic resonance, nuclear reactions, and nuclear models. The work is organized by the Science Faculty of the University of Paris, and includes practical work.

Radiobiological training is also provided. It deals with the biological action of ionizing radiations from reactors, accelerators and isotopes, and with radioactive indicators. It is a valuable prelude to research, and is applicable not only to those with medical or pharmaceutical leanings, but to members of the science faculties and " Grandes Ecoles." Designed specifically for research workers, such a course does not lead to any medical qualification, nor does it have any immediate bearing upon therapeutic problems. The course can occupy one or two years. In the latter case, the second year is devoted to a research problem. A diploma is issued to each student who successfully completes the work and presents a thesis.

Finally, though by no means of least importance, is the training in the use of radioelements. This is of use to industrial scientists, research workers, and people in various branches of medicine. Such courses are organized by INSTN each year, and consist of two sessions, each of six weeks. Participants are given lectures and practical experience in the use of tracers.

Two-week Courses

More recently an interesting innovation has been introduced, in the shape of two-week courses covering modern developments over virtually the whole field of atomic energy. Naturally, these can hardly be called specialist courses, but they are designed to impart a more generalized information. These courses have been organized at INSTN, with the collaboration of the OEEC's division, the European Nuclear Energy Agency. The first was held in 1957, and the second during the summer of 1959. The latter course was restricted to about 50 science teachers from universities and technical

The INSTN Van der Graaf accelerator

colleges, and it drew participants from Austria, Belgium, France, Germany, Italy, Luxembourg, Portugal, Spain, Switzerland, and the United Kingdom. It was among these participants that I was fortunate to be included.

Valuable Meetings

Although, as in 1957, there was a parallel course held simultaneously at Harwell, I was delighted to have the opportunity to join in the French course, having already seen most of the British Establishments. I felt that while the value of the information imparted during the lecture sessions and visits was not to be underestimated, one of the most valuable features was the chance to meet scientists from other countries. Quite apart from the lectures, which covered most of the general aspects of nuclear energy, as well as more specialized topics, there were several interesting visits. During the latter, the course participants saw French reactors such as EL-3, Triton, Aquilon, Zoe, and Proserpine, as well as accelerators such as the linear type, cyclotrons, and a large proton synchrotron, Saturne. There were also on view the laboratories for biology, chemical analysis, metallurgy, mechanical testing, at Saclay, the nuclear physics laboratories at Orsay, the research centre at Fontenay-aux-Roses, the hot laboratories in which irradiated fuel elements are handled and studied, and the uranium processing plant at Le Bouchet.

Training is Intense

Since 1957 there has functioned at Saclay the Centre Associé du Conservatoire National des Arts et Métiers. This centre accepts technical staff from CENS and other nuclear centres. The students join a two-years' course of mathematics and theoretical and practical physics. Success in the examinations brings the Paris CNAM award, and a further two years of study can then lead to the engineer's diploma. The training is rather intense, since in four years the students aim to achieve a qualification which normally takes seven or eight years. Students at the centre are also given classes in quantum mechanics and technical languages.

INSTN has a splendidly equipped laboratory for training purposes, housed in a building which is still in the course of construction. It includes a small accelerator for neutron production, a graphite moderated polonium-beryllium neutron source for flux distribution work, a gamma-spectrograph, a subcritical pile assembly, a wide range of counting equipment, a heat exchange set-up, chromatographic and ion-exchange equipment, and biological experiments. Some idea of the range of practical work for which equipment is permanently set up in this laboratory may be obtained from the following. This list was selected at random, and is not exhaustive:—

1. Thermal and fast neutron flux distribution from a polonium-beryllium source in a graphite block;
2. Gamma-ray spectrography;
3. Production and study of fast neutrons from the D+D reaction;
4. Study of radioactivity by the coincidence method;
5. Detection of neutrons;
6. Dosimetry of gamma rays by ferrous sulphate method;
7. Half-life measurement by means of the G.M. counter;
8. Contamination and decontamination studies;
9. Isotope exchange reactions;
10. Micro-determination of silver by radioactive tracer;
11. Szilard-Chalmers effect and nuclear isomerism;
12. Study of a chemical reaction by artificial radioactivity;
13. Radioactivation analysis;
14. Ion exchange chromatography;
15. Synthesis of cysteic acid and taurine from sulphite in an egg.

Some of the equipment installed at the INSTN laboratories

On some of the courses students have access to equipment installed at the CEA mechanical research laboratories, accelerators installed at CEA plant and the Faculty of Science, Paris, the Saclay and Marcoule reactors and the CEA biological unit.

It is clear that the training facilities in practical work have been arranged with thoroughness and imagination.

Akin to U.S.A. Methods

In certain specialist fields there are now operating agreements between the Commissariat and the university laboratories. The CEA is linked in this way with the Universities of Algiers, Bordeaux, Clermont-Ferrand, Grenoble, Lyon, Montpellier, Nancy, Paris, Rennes, Strasbourg, and Toulouse. The very close collaboration between the national atomic energy authority and the universities in France resembles that which obtains in the U.S.A., a collaboration which is deeper and more extensive than that in the United Kingdom. It certainly breeds a very enthusiastic atmosphere both in the educational establishments and in the various government atomic establishments. This enthusiasm was very apparent at Saclay, and was marked by many of the overseas participants in the course which I attended there.

Nuclear Shipping – SAFETY PROPOSALS

AN international conference is to be held in London at the end of May and beginning of June to consider the revision of the 1948 International Convention for the Safety of Life at Sea. Among items to be discussed will be the problems associated with nuclear shipping. The United Kingdom is to propose the adoption of a schedule of recommended procedure for the construction, operation and control of nuclear propelled merchant vessels.

The schedule will be based on the recommendations of a committee appointed by the Ministry of Transport in 1958 "to advise on safety problems arising from nuclear propulsion in merchant ships at sea and in port." The committee has recently published its report.* Though it was primarily concerned with British shipping, because of the international nature of the problems involved it was decided to include recommendations for adoption on a world-wide basis.

The committee comprised representatives of the Ministries of Transport and Power, the United Kingdom Atomic Energy Authority, the Admiralty, and various shipping, shipbuilding, port and classification organizations. From their report it is obvious that they tackled their task with thoroughness and commonsense. All aspects of the problems involved are covered, including even the salvaging of nuclear ships.

Ten Year Trial Period

Right from the start the committee make it clear that their proposed safeguards relate only to an initial period of ten years. After that they should be revised. With further developments and experience in nuclear engineering it might become possible to scrap some of them. Furthermore, new safeguards might be necessary.

In the international field the committee suggest that initially individual countries should adopt their own rules of procedure, based on recommendations such as those to be put to the forthcoming conference. It is felt that binding agreements made at this stage between countries might prove embarrassing to some of the participants.

Of all the peacetime hazards that could occur to a nuclear ship and give rise to a release of fission products a collision abreast of the reactor with another large, fast moving vessel is considered the greatest. An explosion could, of course, rupture a reactor vessel, but the committee maintain that if their recommendations relating to design and construction and to the carrying of certain types of explosives as cargo were followed, the explosion risk would be negligible. Apart, that is, from wartime hazards such as bombs and mines.

The committee also consider the effect on a reactor of other hazards such as groundings and fires to be negligible, provided, of course, the appropriate precautions are taken.

No danger is envisaged from faults that might occur in the reactor system itself. Nevertheless it is suggested that in the initial period nuclear ships might be limited to selected ports and berths.

No Privileged Treatment

So confident are the committee in the safety of the reactor propelled ships that they feel that such ships should not require privileged treatment in relation to general navigation. Neither should there be an attempt to modify the International Collision Regulations. These, they say, must apply to nuclear ships as to others. A change could "only result in confusion."

They also feel that no restrictions should be placed on the right of innocent passage of a nuclear ship through the territorial waters of a State. It is further recommended that pilotage should not be compulsory for nuclear ships in United Kingdom coastal waters where pilotage is not normally required. An alternative source of power should be immediately available, however, when the ship is in territorial waters. This source it is proposed should either be a second reactor or some other arrangement whereby the ship can "proceed at a navigable speed for not less than five days."

As a nuclear ship would not enjoy any special status it would be unnecessary for it to display any special distinguishing signal. An exception to this would be made when any discharge of radioactive materials occurred accidentally or beyond the scope of internationally agreed arrangements. In such circumstances, the committee recommend that in day-time a warning signal consisting of a sphere over a downward pointing cone should be displayed. At night the ship should direct a searchlight beam vertically from the bridge.

Automatic Shutdown

Recommended safeguards to be included in the design and construction of nuclear powered ships are listed in 25 paragraphs. Among them are suggestions that the machinery and reactor installations should be capable of operating under all seagoing conditions of rolling, pitching, heaving and a permanent list of 20°; the reactor coolant system should operate effectively at all angles of heel and of list up to 70°; and the reactor shut-down arrangements should be capable of operating up to an angle of list of 90°. In addition, the shut-down should be automatic when the ship either becomes submerged or heels to an angle of 50°.

For the information and guidance of the officers and crew it is recommended a fully detailed "Operating Manual" should be prepared for each ship. This publication would have an important bearing on the safety of the ship and nuclear installation, as well as providing operational details.

The committee would like all deck officers to receive a course of instruction in the basic principles of nuclear energy and its application to merchant ships, particularly as applied to their own ship. Engineers are expected by the committee to attend a 12 to 15 month instruction

(*Continued on page 233*)

**Report of the Committee on the Safety of Nuclear-powered Merchant Ships. Command Paper No. 958. H.M. Stationery Office. Price 3s. 6d.*

Gas-lubricated Bearings

meet special needs of N-plant

ONE of the incidental problems associated with the development of nuclear power stations is the design of circulators and pumps to circulate heat transfer media. The heat generated in the reactors has to be transferred to the steam generators by some fluid which continually circulates in a closed system—absorbing heat in the reactor and giving it up in the generator. British plants use as heat transfer media gases such as carbon dioxide, helium or nitrogen or metals such as mercury, sodium or bismuth in liquid or molten form.

The design of circulators and pumps to maintain the circulation in such systems set unprecedented problems. The heat transfer medium—whether gas or liquid metal—is under pressure, at a high temperature and probably radioactive to an extent that would be dangerous if any were to escape. Moreover it must have a high degree of chemical purity and no contamination can be permitted.

These are very difficult conditions for any conventional pump or circulator to meet and it was found that no mechanical seal can be relied upon to prevent completely both contamination by lubricant and leakage of the transfer medium. Trouble can also arise from the breakdown of lubricants under irradiation.

The solution was to use gas-lubricated bearings. They made possible the design of electrically driven centrifugal circulators and pumps which could be assembled clean and dry and could be enclosed so that on installation they were completely sealed from the atmosphere.

The idea of the gas-lubricated bearing is not new, but the practical difficulties of manufacture proved too great until the needs of nuclear engineering made it essential to overcome them. They are fundamentally the difficulties of all high-precision engineering—of expansion and distortion, of obtaining the necessary standards of roundness and straightness in journals and of flatness in thrust faces. The gas film is of the order of 0.0001 in. thick and the bearing clearance about 0.0005 in. per inch of diameter.

Gas bearings are of two kinds, referred to as hydrostatic and hydro dynamic or self-acting. In the hydrostatic bearing gas is supplied under pressure in much the same way as oil to a conventional pressure-fed bearing.

Bristol Siddeley Choice

In the self-acting type, used in Bristol Siddeley units, rotation of the shaft draws a film of gas between the journal and the bearing as soon as a certain minimum speed has been exceeded. When starting and stopping a certain amount of rubbing must therefore occur between the shaft and the bearing until sufficient speed has been attained, and for this reason they must be made from dissimilar metals with good anti-galling properties.

In Bristol Siddeley gas bearing circulators the circulating gas fills the body of the unit and serves as the lubricant for the bearings. The pump units are mounted with the shaft vertical and the impeller below the surface of the liquid being pumped. The motor chamber is filled with a suitable gas which will lubricate the bearings and will not oxidize or otherwise react with the liquid.

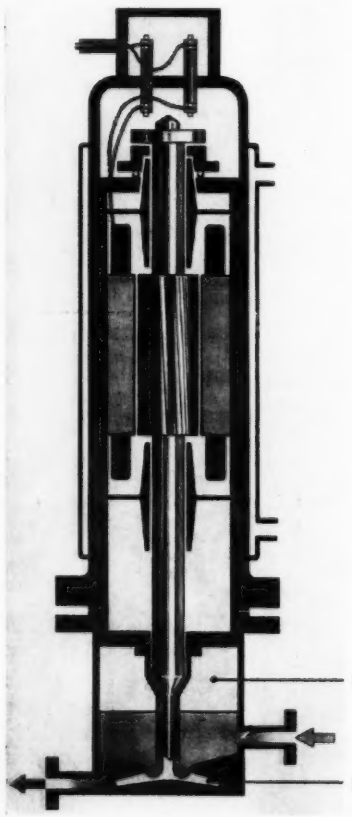
In contrast with normal lubricants the viscosity of gas increases with temperature and the strength of the gas film improves with shaft speed and gas pressure. The load capacity of the bearing thus increases with temperature and shaft speed instead of decreasing as with conventional lubricants.

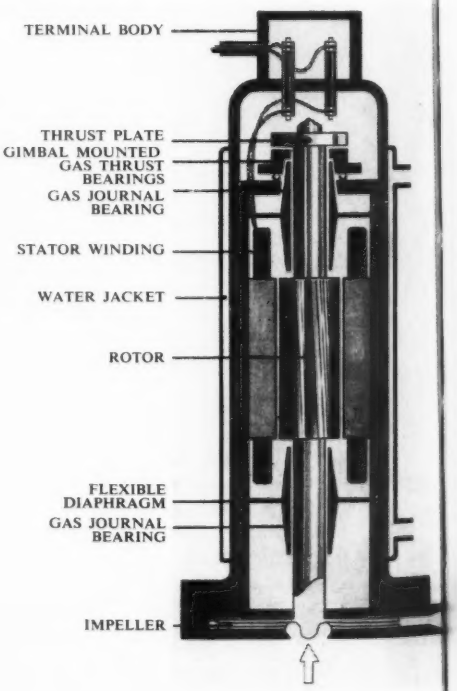
Once the gas film has been established there is no metallic contact between the shaft and the bearing and no wear should occur. Examination of Bristol Siddeley gas bearing units which have run continuously for a number of years shows that this is borne out in practice. No measurable wear can be found. Thus these units require no maintenance and have for practical purposes an infinite life.

The first gas bearing circulators and pumps were developed at the Atomic Energy Authority's research establishment at Harwell, but their manufacture and later their design as well were undertaken by Armstrong Siddeley Motors and are now an important activity of the power division of Bristol Siddeley.

Bristol Siddeley gas bearings are at present being produced in sizes up to 8 in. in diameter, and the pumps and circulators in which they are used are manufactured for pressures up to 1,800 lb/sq.in., temperatures up to 700°C. and powers up to 1,750 h.p.

In addition to the large units used as main circulators, a variety of smaller units is manufactured for sampling transfer media, as coolant circulators on charge/discharge machines, for heat and mass transfer rigs and many other purposes in the course of nuclear research. They are an essential feature of all nuclear power stations being built for the Central Electricity Generating Board and no doubt they will find many applications outside nuclear engineering. They offer complete freedom from contamination or leakage—operation at high temperatures and pressures—ability to handle radioactive or corrosive materials—no wear—no maintenance and, being totally enclosed, imperviousness to dust and dirt. These are characteristics which could be most valuable in other fields—for example in the chemical industry, the processing of foods and the manufacture of pharmaceutical products.





(*Left*) Gas bearing pump
(*Right*) Gas bearing compressor

RADIATION in the Chemical Industry

Part II

by F. R. Paulsen, BSc, PhD, FRIC, MINucE

(*Continued from page 165*)

LAST month I referred to the formation of hydrazine by irradiating ammonia, the NH_3 molecule being broken down to the NH_2 and H radicals the NH_2 radicals combining to form hydrazine. A very similar reaction, at least on paper, although rather more complex in mechanism, is the formation of glycols from alcohols. Thus, methanol, CH_3OH, on irradiation, will give the radicals H and CH_2OH, and the latter then polymerizes to give CH_2OH CH_2OH, or ethylene glycol, the substance used as anti-freeze by drivers. There can be no doubt that irradiation methods, especially if they can involve chain reactions with high *G* values, could show promise in a wide range of reactions, such as oxidations, hydrogenations, nitrations, sulphonations, aminations.

Nitric Acid Production

The fixation of atmospheric nitrogen has been a reaction to attract the attention of the radiation chemists. It has been shown that the efficiency of the conversion of nitrogen and oxygen of the air into nitrogen oxides (subsequently converted into nitric acid and nitrate fertilizers) can be increased five-fold if the ordinary temperature and pressure are increased, say to 200°C. and 375 lb/sq.in. respectively. This would mean that a single reactor of 500 MW (thermal) could manufacture 500 tons of nitric acid, compared with the average British output of 750 tons daily. The advantages of the irradiation process are obvious, therefore. But are there any snags? What of the economic aspects?

If the reactor is run for the manufacture of nitric acid only, then the cost of the product would be about £36/ton assuming about 37 per cent. utilization of the fission product energy. Since the current price of nitric acid is around £30/ton, this offers no obvious advantage, then. Should the reactor be used for production of power *and* nitric acid, the economics would be far more favourable, but the design of the reactor would be very tricky.

Gasifying Coal

The use of reactors and radiations for the gasification of coal has been the subject of considerable investigational work. In the U.S.A., for example, the Bureau of Mines has operated a pilot plant in which oxygen and steam superheated to 540°C. are used to gasify coal at 1,370°C. A reactor to achieve the same purpose would need to operate also at 1,370°C., and this is not possible at present, nor in the very near future. Powdered coal and superheated steam at 300 lb/sq.in., will react at even 950°C., giving hydrogen and carbon monoxide, which could be made the starting point for many organic chemicals. Even this temperature is not readily attainable in a reactor at present.

A reactor to convert coal into water-gas at the rate of 1,500 tons of coal/day would have to have an output of over 300 MW (thermal). If such a reactor were to be made, this might eliminate the need for oxygen and increase efficiency, since it would be no longer necessary to burn some of the coal to produce the requisite degree of superheat in the steam.

Cobalt-60 Used

Another approach to the problem is being taken at Columbia University, New York. There, a 20 lb block of cobalt-60, with an activity of 1,400 curies, is being used to study the effects of radiations on the hydrogenation of coal to methane. Coal is heated and irradiated, when under high pressure it becomes converted into hydrocarbons such as methane, and including liquid products of the gasoline type. This work, sponsored by the Consolidated National Gasoline Co., may take over 20 years before it reaches the large-scale stage.

The Organic Moderated Reactor, of such interest in the production of nuclear power, both for land-based stations and for ships, may also prove its worth in the field of radiation-produced chemicals. Many substances will dissolve in the organic materials which are used as the reactor's moderator and coolant, and if circulated with this liquid, will gradually undergo change into products which might be of commercial importance.

Benefit for Plastics

Perhaps one of the most fruitful fields of industrial radiation chemistry lies in the manufacture of plastics of various types. Innumerable films, plastics, fibres, coatings, and so on, are made by addition polymerization activated by catalysts such as organic peroxides. The elimination of these catalysts would certainly result in purer products, and freedom from polar materials, so that there might result marked improvement in properties. Again, many of these polymerizations require quite high temperatures and pressures. The polymerization through irradiation can fundamentally change all this, since it usually occurs at low temperatures, and at moderate pressures.

To take an example, polyethylene is normally made at 2,000 atmospheres and 200°C., and side reactions occur, involving branched-chain formation, and consequent imperfect crystallinity, since the molecules refuse to pack closely. The melting range is also wide and low. On the other hand, polyethylene formed

under the effect of radiations can be made at pressures of only 10 atmospheres, and at room temperatures, and the product is more crystalline, and of higher melting point.

At Lower Temperatures

Many other interesting possibilities, too, arise in this field. Acrylamide normally polymerizes only at its melting-point, 80°C., but on irradiation, this process occurs at 15°C., and is very rapid, the crystals being converted visibly into an amorphous polymer. Acrylic and methacrylic acids can be polymerized at —15°C., which is below their melting-point, while in the case of tatraethylene glycol dimethacrylate the process will take place even at —55°C. on irradiation.

Addition polymerization can also be induced readily by the irradiation of styrol, methyl methacrylate, vinyl chloride, vinyl acetate, and other monomers, and butyl rubber can be made in this way. There has in the past been considerable difficulty in the polymerization of the fluorinated monomers, but even these are amenable under irradiation. It is in this way polymers have been made, for example, from perfluorethylene, perfluorpropylene, perfluorbutadiene, and even 1,1-dihydroperfluorbutylacrylate.

Co-polymerization

Now, addition polymerization consists in the conversion of radicals of type A into long chains AAAAAAAAAA.... When two monomers are mixed, say A and B, then chains such as AAABBBBAABBBAABBB.... may be formed, and this is called co-polymerization. An even more interesting type of polymerization occurs, if the radicals form side-groups, *i.e.*, of the type

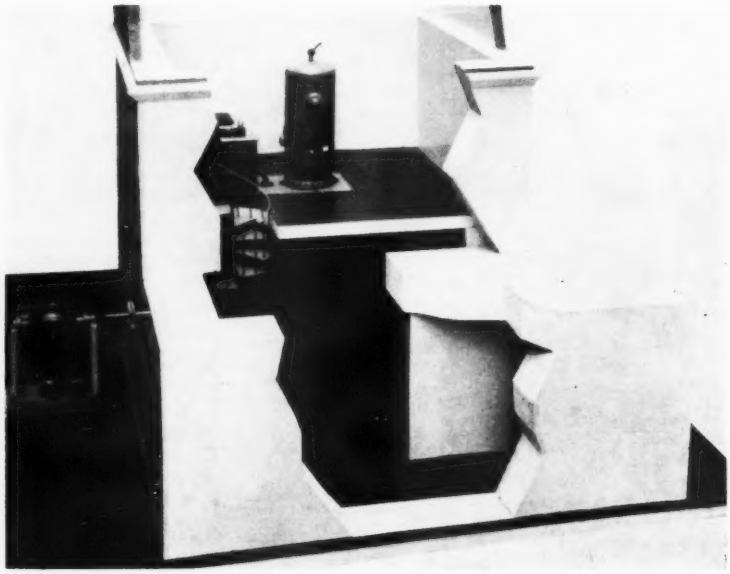
```
AAAAAAAAAAAAAAAAAA
 B     B     B
 B     B     B
 B     B     B
```

This is called graft polymerization and gives rise to many interesting features especially as it is especially amenable to irradiation induction.

Plastics for Special Uses

Irradiation produces activation of points in the main chain, which are then attacked by radicals from the sides. For example, if polythene is irradiated, and then immersed in acrylonitrile, the latter becomes polymerized as side-chains on the main chain of the polyethylene. This process makes it possible to tailor molecules for certain purposes, so that plastics may be made, for example, with certain tendencies for vapour permeability, and so on.

This process may even be done on semi-finished products, such as tubes, foils, etc. Thus, polythene tubes immersed in acrylonitrile and irradiated give graft hybrids 43 times as strong as the original, and much less permeable to organic liquids and vapours.



Model of the radiation pilot plant at the laboratories of British Insulated Callender's Cables where polythene cables are irradiated (*Right*) Untreated and irradiated samples of polythene cable after heat treatment

Heat Resistant Materials

Again, polyvinyl chloride (PVC), treated with 20 per cent. of acrylonitrile and irradiated, gives a very heat-resistant material, which may one day be used for hot-water systems. The base polymer, instead of being in the form of a film, can also be in solution, or merely swollen with the desired monomer. In this case irradiation causes alteration of the whole plastic, on not just the surface. The irradiation of a mixture of polymethyl methacrylate and styrene resin gives a product consisting of polymethyl methacrylate (Perspex), some polystyrene, and chains of the co-polymer.

It is often possible to get properties better than those of either of the single polymers, although some bad features may be retained in certain cases. Thus, acrylonitrile grafted on to a silicone rubber consisting of vulcanized polydimethyl siloxane, retains the rubbery nature over the range —60 to +200°C., but is still soluble in many organic solvents. Grafts of polytetrafluorethylene with styrol show many excellent properties, while the same PTFE, grafted with polythene, shows marked increased resistance to chemical attack. Even cellulose grafted with synthetic resins can prove very highly resistant to chemical attack, and makes very useful fibres.

Stability Compared

Aromatic (benzene ring) compounds are more stable than aliphatic (carbon chain) compounds. Thus, 3×10^6 rad will be sufficient to rupture the bonds in polystyrol to

the extent of 50 per cent., but equal rupture in polymethylmethacrylate requires only 5×10^7 rad. Some of the most stable to chemical bond rupture are asbestos-filled resins of the phenolic and furane types.

It must not be assumed that the effects of radiation are invariably favourable. Thus, some plastics, such as polytetrafluorethylene, the methacrylates, and butyl rubber, under irradiation, undergo severe degradation, and become virtually useless, unless grafted.

Instead of Vulcanizing

Elastomers may be cross-linked by radiation instead of by vulcanization. Thus, exposure to 10^7 rad will convert natural rubber into a product similar to normal vulcanized rubber, except that the —S—S— linkages are replaced by —C—C— bonds. The resistance of such products is often markedly superior to those of vulcanized materials. Thus, chemically vulcanized acrylate elastomer is degraded by 175°C. after 8hr, while the radiation-vulcanized product can withstand this temperature for over 36hr. Furthermore, acrylates are easily vulcanized by irradiation, but the chemical process is not simple.

In some cases, it is possible, through irradiation graft formation, to improve the surface properties of polymers. Thus, floorings can be made highly resistant to scratching by chairs and tables, while still retaining their desirable resilience. Again, polyethylene foils can be made more adherent to paper, metals, wood, and glass. The glass-reinforced polyester resins used for car bodies can be made much stronger by irradiation.

Natural Rubber Improved

Rubbers, both natural, synthetic, and of the silicone types, can be improved by irradiation vulcanization. This method eliminates the need for catalysts and accelerators, and heat treatment also. Thus, the product is purer, the vulcanization more uniform and thorough.

There can be no doubt that irradiation has a great future in the chemical industries, and the first to benefit will undoubtedly be the plastics manufacturers and consumers. In Great Britain, it is estimated that irradiation will add about 1*d.*/lb to the price of the product, but this will be easily offset by the greatly improved properties.

What of the future, then? It may safely be said that there *is* a future for the use of radiations in industrial chemistry, quite apart from such obvious uses as level gauges, thickness meters, static eliminators, and the like. Radiation must play its part in the actual manufacturing processes. The scope is a wide one; manufacture of new and modified plastics; production of new types of fuels, by the cracking of hydrocarbons and by coal gasifications; manufacture of inorganic compounds such as hydrazine, hydrogen peroxide, and organic materials such as glycols, aniline, phenol, etc.; formation of organic chemicals from water-gas; many more are likely to be found as studies in radiation chemistry progress.

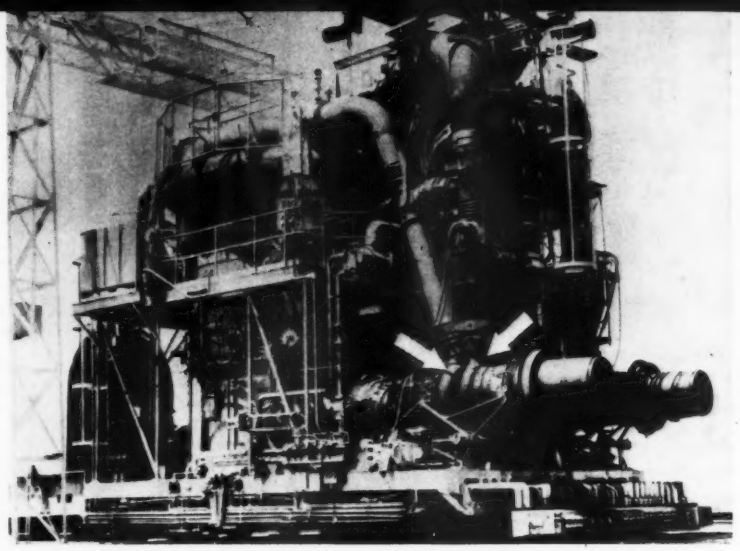
Naturally, there will be difficulties. Firstly, reactors will be required which can produce temperatures well over 1,300°C.; organic moderated reactors will be developed for chemical processes; new and more powerful types of accelerators will be produced for the treatment of polymers. All of these will require great forethought, if the costs of production of irradiation-induced materials are to be kept low.

Prepare for Hazards

Then there is always to be borne in mind the hazards—chemical works will become similar to atomic research laboratories, in needing constant vigilance, health physicists, and special waste disposal systems and legislation. Again, materials treated by irradiation will have to be exceedingly pure, since the products may otherwise be highly radioactive, as the result of induced radioactivity in some impurity atoms.

Let us not be too optimistic, nor too pessimistic, of the future. There is ample scope for the chemist, the engineer, and the physicist; their combined efforts may well revolutionize chemical industry, but this revolution may be a long time coming.

Vulcanization of rubber by irradiation. (*Above*) **Technicians lower specimen into lead brick enclosure containing cobalt-60.** (*Right*) **Technician compares irradiated rubber** (*in left hand and on table*) **with un-irradiated specimen** (*in his right hand*)



The equipment used by General Electric Co., of America, for running a modified aero turbojet engine on nuclear power. It is sited at the National Reactor Testing Station, Idaho Falls. Special scrolls (marked with arrows) were made by the Ryan Aeronautical Co.

N-Aircraft Test Rig

A NUCLEAR aeroplane has not yet been built, yet it has recently been shown that nuclear energy can supply enough heat to power a jet engine. In Idaho, the General Electric Co. recently collected the heat from a nuclear reactor in specially designed scrolls made by Ryan Aeronautical Co., and pushed it through a converted J-47 jet engine.

To keep the weight and size of a nuclear aeroplane down to a reasonable figure, say 200,000 lb, it would be better to shield the passengers and crew rather than the reactor. In fact, tests conducted by Convair, who recently installed a 1,000 kW reactor in a B-36 aircraft, indicated that reducing shielding weight can be effected by dividing it between the reactor and the flight crew's compartment.

While important, the solution to the problem of proper shielding must await the development of a power unit which will fit inside a 3 ft diameter × 3 ft cylinder, and which would develop about 30 MW of heat. At 750°C., this output would produce the equivalent of 10,000 h.p.

General Electric Co., in its development programme located at the National Reactor Testing Station, near Idaho Falls, Idaho, have made some progress towards this goal. They have run a modified J-47 turbojet engine—designated the X-39 for this purpose—for more than 100 hours on nuclear power alone.

This nuclear power plant is the direct cycle type, in which the engine air passes through the reactor to cool the reactor as well as to provide thrust. Although in a final design the reactor would be in the same package as the turbojet, in the test set-up the reactor is apart from the engine. It is a massive unit, mounted on a railway flat car. Ease of access and maintenance, and installation of a great deal of testing and recording equipment dictated the size of the test bed.

Air Route

In operation, air is drawn into the engine intake, compressed, collected in a special scroll mounted behind the engine compressor, and then routed through the reactor core. Heated by the nuclear process, the air then returns to a second scroll, is used to turn the turbine which drives the compressor, and is then exhausted through the jet to provide thrust.

In the test bed, the atom gets some help from conventional chemical fuels. General Electric engineers installed a combustion chamber in the ducting which returns from the reactor. The engine is started up on conventional chemical fuels situated in this chamber. When the heat from the reactor builds up the chemical fuel is shut off.

When the nuclear-powered plane becomes a reality, it is most probable that, like the turbojet engine, it will be used primarily for military purposes for some years to come. There are several types of military aircraft that can profitably use atomic power.

Seaplane Logical Choice

Most obvious is the nuclear-powered seaplane. The big flying boats could cruise indefinitely on anti-submarine warfare patrol, as airborne early warning ships, and on long-range patrol and reconnaissance. They would be invaluable in weather, search and rescue missions, and their potential for high speed would make them highly suitable as a low-level attack bomber.

From the standpoint of commercial craft, the seaplane might also be the logical choice. A nuclear-powered commercial transport would have to be of gigantic size, able to carry hundreds of persons single flights of 5,000-mile range, in order to justify the initial cost of construction. And, since there is so much water available as runway space, perhaps the day will come again when the seaplane rules the passenger trade on the intercontinental runs, as it did in the 1930s.

The nuclear engine is not limited to the pure jet. Atomic energy can also be used to power propjets, either by bleed air from the reactor, or by installing a reactor in line with the engine, as with the turbojet. Such propulsion units would be used in very large logistic transports, which could deliver vital material or personnel to any place in the world, and return to the United States without refuelling.

Ryan Aeronautical Co. has built the scrolls used in the General Electric atomic test engine in Idaho. The units are made of stainless steel, Inconel, and L605 alloy. Tolerances, for the most part, had to be held to within $^{5}/_{1000}$ in. These tolerances were not only called for in machining flange faces, but in maintaining overall dimensions.

Typical of the care which was called for was the construction and placement of the rib assemblies which surround the opening in the scroll. About 5 in. long, these 16 ribs had to be clamped to the cone assembly in equally spaced positions, and then led through openings in the outer cone. Spacing between ribs, and the length of the ribs, had to be held within $^{5}/_{1000}$ in. In addition, the opening through which the ribs passed had a clearance of only $^{5}/_{1000}$ in.

Book Reviews

Bulleten Izobretenii, U.S.S.R. Patents and Inventions, Volume I of a new translation service by Pergamon Press Ltd. Annual subscription rate £50 0*s*. 0*d*.

If this volume, which comprises Nos. 1 to 2, 1959, can be taken as any criterion, this new translation service should prove invaluable. The patents cover 17 fields—chemistry and chemical engineering; electrical and mechanical engineering; agriculture, forestry and horticulture; electronics; metallurgy; mining; measuring instruments; civil engineering; industrial gases; textiles and clothing; building; fuels, furnaces and prime movers; food and allied industries; public health and medicine; paper and allied industries; light and precision engineering; aeronautics. It is sometimes a little difficult to justify the position of some of the entries; for example, entries on the use of an external indicator for acidimetry in coloured solutions, lead tetra-acetate for moisture determinations, and a complex metric determination of potassium appear, for no logical reason, under "measuring instruments," instead of under "chemistry." Preparation of ion exchange resins crops up in all sorts of headings. Terminology is sometimes decidedly loose, as in "selenium metal," "nitrous bases," "electrical static fields;" some organic formulae are problematical; there are many misspellings, such as "columb," "foodsstuffs," and "thiobensoic," some awkward Americanisms such as "carbon is sublimed by placing on a heated cathode" and "dewaterer," and "gm." for "g." (this one is very inconsistent in this book); one patent entry appears twice on one page. It is also very disconcerting to find that every entry contains the phrase "characterized in that..." Perhaps the strangest of all is the very nature of some of the entries. In an age when plate glass is made in colossal amounts by very efficient processes. it is strange to read of a gob of glass being squeezed out in order to attain this end. Is the use of pressurized hot water sprays for the cleaning of hides something new? A formula for a blue-green glass looks far from new to me. It is amusing, too, to read a patent for a "child's dummy teat," with a disc between the two halves—the sort our grandmothers gave their children. And even magnetic stirrers, so long a feature of our laboratories, have been rediscovered in the U.S.S.R. It is difficult to say whether such discoveries have been made through reading some of the older Western technical literature, or whether they are genuine rediscoveries. In spite of these drawbacks, and after a period of settling down, this translated patent service should be of interest, and occasionally of value, to many, including nuclear engineers.

F. R. PAULSEN, MINucE

Liquid-Metal Heat Transfer Media by S. S. Kutateladze, V. M. Borishanskii, I. I. Novikov and O.S. Fedynskii. Translated from Atomnaia Energiia, Moscow, 1958. Published by Consultants Bureau, Inc., New York; Chapman & Hall, Ltd., London. Size 8¾ in. × 11 in. × 149 pp. Price 180*s*. 0*d*.

The standard work on liquid metal technology is *Liquid-Metals Handbook* (*1950*) and its 436 page "Sodium and NaK Supplement (1955)," sponsored by Admiral Rickover and the U.S. Atomic Energy Commission. These most opportune publications were enthusiastically received, especially by nuclear engineers, for the large amount of information they summarized and their methodical presentation, whilst their low cost of 15*s*. 0*d*. and 18*s*. 0*d*. respectively was most acceptable. At first sight *Liquid-Metal Heat Transfer Media* appears a belated attempt by Russian technologists to cover the same ground (particularly as the jacket design features the best known *Liquid-Metals Handbook* table on corrosion-resistance). The foreword claims the same object, namely "to systematize and generalize the copious data on the study of heat removal of liquid metals." Closer scrutiny reveals considerable differences both in price, which prohibits private purchase, and in content, which is much more restricted in scope, more academic in style, and differs greatly from *Liquid-Metals Handbook* which concentrates on data and "know-how," with long theoretical discussions being discouraged. The lack of an index in the new publication also makes it inconvenient as a reference book. Following almost ten years after *Liquid-Metals Handbook*, it would have been hoped that much new data would be included, particularly on the need for high purity in liquid metals (to achieve optimum heat-transfer and to reduce corrosion) and methods of achieving this; however, this is scarcely mentioned. In general, there is an absence of original information of this period. Nevertheless, the book is useful as an alternative source of data and makes Russian contributions more readily available to workers in the West. The coverage is most exhaustive in the case of mercury; sodium and sodium-potassium are covered in much less detail. The general content of the book is as follows. The opening chapter is devoted to liquid properties: nine tables are included (mercury, sodium, potassium, lithium, bismuth, tin, lead, 25/75 NaK, 44.5/55.5 Pb Bi) introduced by the categorical remark that they "were obtained in the laboratory of Academician Mikheev;" however, it is later acknowledged that much of this data is not original Russian data. A chapter is devoted to hydraulic resistance to flow and the bulk of the book, seven chapters, to heat transfer, including: general considerations; heat transfer in tubes; around plates; around cylinders; during free convection; during vapour condensation; during vapour boiling. This is followed by a short, superficial, dissertation on heat-exchanger equipment and instruments, and a chapter on resistance of materials to liquid metals.

L. R. BLAKE,
UKAEA, Dounreay

Encyclopedic Dictionary of Electronics and Nuclear Engineering, by Robert Sarbacher. Published in the United Kingdom by Sir Isaac Pitman & Sons Ltd. Size 7 in. × 10 in. × 1,417 pp. Price £8 0*s*. 0*d*.

This *magnum opus*. it took the compiler 12 years to collect, collate and cross reference the information it contains, will surely find its way into every science library in the land. It must be about the most comprehensive guide to nuclear engineering and electronics of its type to be published. There are over 14,000 entries, 17,000 cross references and 1,400 illustrations. Text, we are told, contains over 1m. words. The entries on the whole are concise and to the point. Some, where necessary, are extended, such as the entry under the heading of "Reactors, nuclear," which runs into 16 pages. A few more pages devoted to this subject and the list of reactors given could have profitably covered all reactors instead of being confined to American-design plant. But then, there is a bias towards American achievements throughout. ZETA and SCEPTRE, for instance, receive little more than 100 words each, whereas the American thermonuclear machines receive much fuller descriptions. Russian progress in this field seems to be ignored, except for one very brief reference to the Russians actually carrying out thermonuclear experiments. Fair coverage is given to non-American fission reactors under their respective headings. Two curious omissions though are the lack of reference to the AGR at Windscale and the DRAGON project. Unexpected, but very welcome, are the entries referring to the sites of British nuclear power stations, though why is Dungeness omitted when Sizewell is included? Some users of this dictionary might deprecate the author's avoidance of personalities—scientists and engineers who have made valuable contributions to the advancement of nuclear technology and electronics. In the opinion of one reviewer this was a wise decision. The inclusion of personalities would have left reviewers far more to argue about. As it is, Mr. Sarbacher's book has to be acknowledged as a massive, worthwhile monument to his industry and knowledge.

T.R.

THE REVIEWERS

F. R. PAULSEN, PhD, BSc, MINucE, *is a regular contributor to* NUCLEAR ENERGY, *is a consultant and lecturer on nuclear matters and is a member of the Council of the Institution of Nuclear Engineers.*

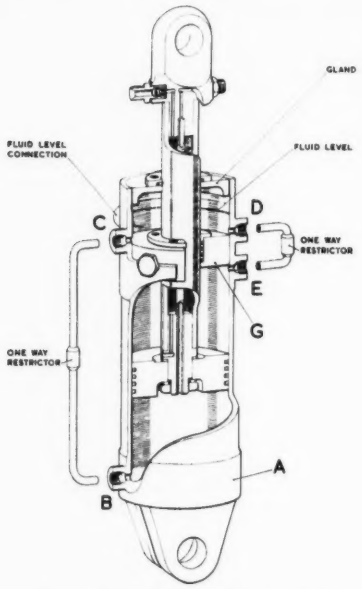
L. R. BLAKE, PhD, BSc(Hons), AMIEE, *is fast reactor technology manager at the Dounreay Experimental Reactor Establishment, was with British Thomson-Houston and specializes in electromagnetic and electromechanical design as well as fast reactors.*

Equipment and Materials

Items published in this monthly feature are compiled from manufacturers' current literature. Readers requiring further information should use the form at bottom of the page. Manufacturers are invited to send literature or details of their products for inclusion in this feature.

Shock Cushioning

Electro-Hydraulics Ltd., Warrington, regard the design and production of hydraulic units required for the protection of structures and relative components from the damaging effects of violent shock or vibration as highly important. Research has established that the failure rate of structures which operate under protected conditions is approximately one-tenth to one-twentieth of those subject to unprotected conditions. An application of particular interest has arisen from the requirements for damping severe shocks such as arise from earthquakes on the gas ducting of nuclear power



Sectional drawing of hydraulic operated shock absorber developed by Electro-Hydraulics Ltd. References to the key letters are contained in the accompanying text

stations. Utmost reliability is demanded of these units which in some cases cannot be approached during the life of the power station but in which the fluid must be changed from time to time. A damper to meet these requirements has been designed by Electro-Hydraulics. The closed end of the cylinder (marked A in the diagram), which is mounted in a vertical position, is formed with an integral forked lug provided for attachment purposes and five bosses forming fluid connections. Moving axially within the cylinder is a piston secured to a piston rod which passes through a diaphragm (C) dividing the cylinder, forming a reservoir and damper chamber. Sealing rings are fitted between diaphragm and piston rod also the gland and piston rod. When the piston moves down the cylinder the fluid displaced passes through fluid connection (B), the restrictor, and subsequently into the reservoir. The fluid from the reservoir will at the same time be drawn unrestricted through connection (D) into connection (E) of the damper. Movement of the piston in the opposite direction reverses this flow sequence. The one-way restrictors incorporated in this unit limit the travel of the piston in the event of sudden movement. Longitudinal drillings in the piston rod permit the passage of fluid through non-return valves to both the upper and lower face of the piston during recharging of the unit, fluid is discharged via the reservoir and out at a fluid level connection. **(MY 1)**

Control by DAME

In order to make progress towards the use of integrated control systems it is necessary to gather and analyse much correlated information on the plant and machinery involved: de Havilland Propellers Ltd., have developed a set of Data Acquisition and Monitoring Equipment (DAME) to do this work and to fulfil a number of closely associated monitoring and control duties. DAME has been designed for extreme flexibility and is adaptable to a wide range of industrial applications at all stages of the introduction of automatic control. Initially, it may be used to gather information on the process only, but as experience is gained, it may undertake wider responsibility. The main functions of DAME which may be performed either separately or in conjunction, are:— (1) *To gather information on performance:* Incoming electrical signals of any form are measured at the rate of one a second to a genuine accuracy of ± 0.1 per cent. Data can be printed by an electric typewriter to form a log sheet or put on to magnetic tape, paper tape on punched cards for analysis and computation; (2) *To monitor continuously the operation of a plant or system:* Incoming electrical signals are converted to digital information and presented as a percentage deviation of the parameter from its predetermined nominal value. In the event of any channel being outside limits, action can be taken in one or more of a number of ways, depending on the significance of the deviation. (*a*) The logged result for that channel can be typed in red; (*b*) A " fail " light can be lit on the display; (*c*) An alarm can be given; or (*d*) The appropriate emergency programme can be initiated automatically to bring the system to a safe condition; (3) *To initiate, check and control a routine sequence of operations, e.g. on " start-up."* DAME can initiate a sequence of executive actions and monitor their results or, on check-out, can inject signals into a system in order to measure their effect. In all roles, programmes can be prepared to meet the particular conditions and requirements and these may be initiated manually, automatically or by the built-in timing unit. A 300

Cut along here

To: **NUCLEAR ENERGY**
147 Victoria Street, London, S.W.1

Please send further details of the following items in the EQUIPMENT and MATERIALS *feature for May, 1960*

Item No's ....
....

IS THIS ENQUIRY CONFIDENTIAL? YES | NO

Enquirer's Name .....
Position .....
Firm .....
Address .....

channel unit with executive action facilities is housed in three 6 ft racks. A 60 channel unit, without executive action, is housed in one 6 ft rack. Other sizes may be built up on a module basis. The only controls are an " on-off " switch, a telephone dial and a cancelling key. The display comprises a three-digit channel identification, a display of the test result with positive or negative sign, and a red fail light. Any channel may be interrogated manually by dialling and channel number. This will then be sampled continuously and the result displayed each second while control action is taken. On pressing the cancelling key the last channel reading is printed out and, if the manual demand had interrupted an automatic routine, this will then continue from the point of interruption. Routines are initiated by dialling the appropriate code and are set up on computer-type patch panels. Several different routines may be accommodated at one time and whole patch panels may be changed in a few seconds to alter the entire programme. Remote control and display equipment has been built for DAME and, since all signals for this purpose are digital, ordinary telephone lines can be used over any distance. DAME can therefore be located near the point of measurement so that low level signals need only be transmitted over short distances. DAME has been built with emphasis on both price and reliability. Transistors have been used exclusively, apart from electro-mechanical devices in the selection and logic circuits, and circuit life is expected to exceed 100,000 hr. As reliability has, from the outset, been considered of first importance, maintenance is simple and infrequent. All circuits fail safe and a short self-checking routine which guarantees the accuracy of subsequent tests can be dialled when required or be included in any automatic programme.

(MY 2)

These cabinets contain executive controller, programmer and normalizers for the Data Acquisition and Monitoring Equipment (DAME) developed by De Havilland Propellers

Nuclear Battery

Five kilovolts, on open circuit, with a no load current of 100 micro microamperes, can be produced with the krypton-85 isotope battery developed by the Radiation Research Corporation of America. The gas emits beta particles which penetrate a solid dielectric substance. The gas is enclosed in a container fabricated from type 302 stainless steel. This particular type of steel was used as it is easy to fabricate, it takes a pressure-proof braze, is corrosion resistant, can be supplied at comparatively commercially low prices, and is stable under irradiation. The thickness of the cell wall is 50-mil. Completed cells are high-pressure pressure tested under 25 atmospheres using the helium-leak-inspection technique.

(MY 3)

Krypton-85 battery designed by the Radiation Research Corporation, U.S.A.

Temperature Control

West Instrument Ltd., of Brighton, have recently started manufacturing a resistance temperature controller and indicator of entirely new design which takes them into the field of low-temperature control. This company has, until now, specialized almost entirely in instruments for the plastics, laboratory, furnace and other industries requiring control at temperatures above 200°C. The new instrument, which is available with stepless, proportioning and on/off control is suitable for a wide span of operating temperatures, and offers precision control and indication to below —100°C. Potential applications for the new instrument are widespread throughout industry, and already it has been installed in a limited number of applications. A temperature indicator and controller has, for instance, been installed for the generating equipment of the linear accelerator at Harwell. A prominent feature of the instrument is the built-in rectifying and stabilizing unit fed direct from a.c. mains instead of the usual battery arrangement. This enables the controller to be used at any time without the necessity of making lengthy adjustments to compensate for battery deterioration, and it enables surprisingly compact dimensions to be achieved. (the frontal measurements of the resistance on/off controller, for instance, are only 7½ in. × 6¼ in.). **(MY 4)**

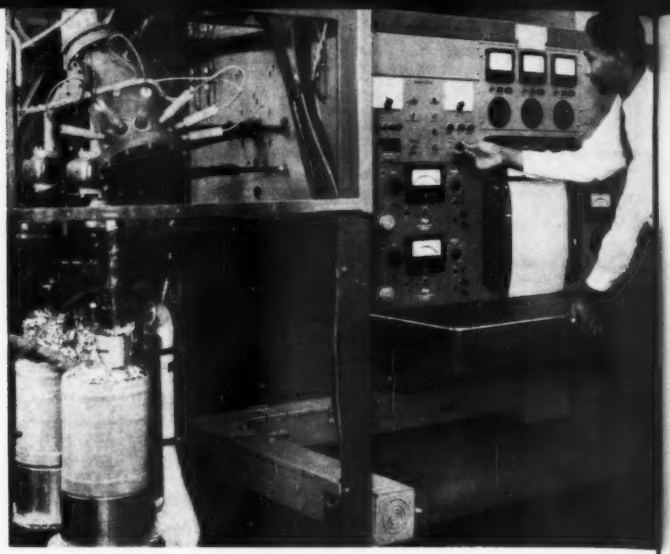
Isotope Fuel Gauge

A transistorized atomic energy gauge which measures the amount of fuel in aeroplanes and missiles with greater accuracy and reliability than conventional devices has been developed for the U.S. Navy by Atomics International, a division of North American Aviation, Inc. In a series of tests conducted by North American's autonetics division, the gauge was installed in a twin-engine jet bomber and environmentally tested at altitudes to 38,000 ft. It performed accurately during all flight attitudes and it was not affected by cosmic radiation or changes in altitude. All types of solid and liquid propellants can be measured by the gauge. It consists of gamma radiation sources, such as cobalt-60 scintillation detectors containing a ratemeter and pulse amplifier, a power supply and an indicator. The sources and detectors are mounted on the sides of each fuel tank. Gamma rays given off by the radioactive materials decrease in intensity as they pass through the fuel, thus the amount of fuel is determined by the intensity of the gamma rays reaching the detectors. The ratemeter converts pulses picked up by detectors into d.c. voltage and the quantity of fuel is recorded in pounds by the indicator.

(MY 5)

KEEPING up the STANDARD

THE U.S. NATIONAL BUREAU OF STANDARDS



Surface ionization mass spectrometer used for determining isotopic uranium standard

EACH year the U.S. National Bureau of Standards distributes 60,000 samples of standard materials to laboratories and research departments for use in controlling chemical processes and in maintaining the accuracy of apparatus and equipment. A total of over 600 different standard materials are available from the Bureau—principally chemicals, ceramics, metals, ores, and radioactive nuclides.

All standards are certified either for chemical composition or with respect to a specific physical or chemical property such as melting point, viscosity, or index of refraction. The standards make possible uniform measurements of heat and temperature, define the colours of paints, and calibrate instruments that control the composition of metals and motor fuels.

Within the past five years, requests from American science and industry have resulted in the introduction of about 70 new standard materials. Meanwhile, 150 new standard materials are being prepared by means of careful analysis and precise measurement. Much of this expansion in the standard samples programme has resulted from current efforts by Government and industry to develop materials having specific properties for use at high temperatures or under extreme conditions.

Started with Iron

The standard samples programme was established in 1905 when the American Foundrymen's Association turned over to the Bureau four sets of cast iron to be standardized for chemical composition. The majority of these chemical standards are metals and alloys, used extensively for monitoring the thousands of analyses made daily in industrial laboratories. Standards of chemical composition also serve as guides in developing new analytical methods for determining the composition of unknown materials. New chemical standards are prepared whenever an industrial need develops. Recent additions include high-temperature cobalt-nickel alloys for jet and missile production, titanium alloys for aircraft and ordnance research, zirconium alloys for nuclear-power development, lithium ores for the new lithium chemical industry, lead-tin bronzes for military purposes, and Portland cement for the cement manufacturers.

Hydrocarbon Standards

About 200 samples of hydrocarbons are issued as "pure substances" and certified with respect to their degree of purity (99.99 per cent.). This category was initiated to fill the gap for standards needed to calibrate instruments, particularly mass spectrometers, employed in controlling the production of synthetic rubber and of special fuels for military aviation. These samples may also find application as gas chromatographic standards.

In connection with the hydrocarbon programme, a new group of standard samples is being developed. Each of these standards will be a mixture of pure hydrocarbons—rather than one pure compound—and will be used mainly for checking gasoline and petroleum fractions. At present, eight such mixtures are under consideration.

A new set of metal standard samples comprises seven types of steels whose oxygen and nitrogen content have been carefully determined. These reference materials are necessary for the calibration of analytical equipment used to determine the gaseous elements in various kinds of commercial steels. Low gas content is a characteristic of metals with desirable properties, and the acceptable amount of gases present in a metal may be expected to be stipulated in procurement specifications for metals and metal products in the future. With the certification of these standards, the Bureau has begun a programme for producing gases-in-metals standards for a number of metallurgical products. Work is now in process to develop standard samples certified for the content of oxygen and hydrogen in titanium alloys.

High-speed spectrochemical methods of analysis have been extensively adopted in recent years by both producers and consumers of metal products. These methods are essentially comparison techniques in which the spectra from unknown samples are referred to the spectra from samples of known composition. Thus, standard samples play a basic role in spectrochemical analysis.

More Planned

The first spectroscopic samples were developed during the last war in response to a need for standards for high-speed control analysis in steel production and inspection. To date, about 120 of the composition standards have been specifically produced for spectroscopic use. Metals and alloys for 44 new spectroscopic standards have been prepared and are being analysed for content and

tested for homogeneity by the Bureau, while final plans have been made for 66 others yet to be prepared.

To improve specific physical properties of metallurgical alloys, minute amounts of certain elements are added. Thus the heat-resistant alloys used in rockets and jet engines contain various combinations of boron, tungsten, molybdenum, titanium, zirconium, niobium, tantalum, and aluminium as well as the major metals. Because of the complex composition of these materials and difficulties in chemical analysis, spectrographic and X-ray methods are used to control their quality in production. The Bureau has been preparing standards which are certified for trace elements as well as major constituents. For instance, in a set of eight ingot iron and low-alloy steels recently prepared—17 elements are included in provisional certificates of analysis, and six more are under study for further certification. Another example is the new set of zirconium standards which is being developed primarily for application in the nuclear energy field. Some 30 elements are under investigation in this set—many at the parts-per-million (ppm) level.

The field of X-ray fluorescence has become increasingly important for rapid analysis. Like optical-emission instrumentation, these newer X-ray instruments require standard samples for their calibration. The Bureau recognized this need several years ago and many spectroscopic standards which are now available or in preparation are designed for X-ray fluorescence analysis. To date 14 standard samples have been developed specifically for X-ray fluorescence while 12 standards are equally suitable for both methods of analysis.

Radioactive Standards

Since 1913, when the United States received its first national radium standard (Radium-6), much of the radium produced or sold in this country has been calibrated against this standard by the Bureau. With the production of radioactive materials in the 1930's, the need for radioactivity standards of elements other than radium has steadily increased, and—in fact, has been accelerated by the discovery of controlled nuclear fission. For radiation safety, for planning experiments, and for ordering and disposing of active material, a knowledge of the disintegration rate of the specimen is essential. Hence, the total efficiencies of radiation detectors under differing conditions must be accurately determined by calibration against radioactive samples.

Today the Bureau distributes standard samples of 40 different types of radioactive nuclides. These standards are used for the calibration of equipment which in turn are used in the measurement of the same types of nuclides. These nuclides have widely varying applications. Several are used medically in the treatment of such ailments as leukemia (phosphorus-32) and cancer (gold-98 and others), as well as in the study of blood formation (iodine-131) and metabolism (carbon-14). Cobalt-60 is used in munition plants to check flaws in casting parts or shell casing. Other nuclides are used to determine such factors as contamination of food crops by strontium-90 and the age of wine and liquors as indicated by the amount of tritiated water present.

Standard samples of mercury-203, niobium-95, and strontium-85 were recently made available for distribution, while 10 point-source standards—including sodium-22 and zinc-65—are being prepared.

Uranium Isotopes

The considerable expansion in the application of uranium and related atomic-energy materials in recent years has emphasized the need of uniform standards which will be widely accepted for standardizing materials and calibrating instruments. Although various U.S. Atomic Energy Commission laboratories and contractors have developed standard materials for their own use, a central set of uranium standards was needed.

To meet this demand, the Bureau issues a series of 15 isotopic standards in co-operation with the USAEC. This set, used by educational and research institutions and industries both in the United States and abroad, contains a graduated series of standard samples ranging from uranium depleted in U-235 to a highly enriched material containing 93 per cent. U-235. Selection of the composition of the intermediate samples was made upon consultation with an advisory committee set up by the USAEC.

In addition to the isotopic range, a natural uranium standard is included in the series. This standard is often used directly as a working standard or control material in experiments. The Bureau's programme is being expanded to include standards for other atomic-energy materials such as plutonium and thorium.

Radiation standards are stored by the U.S. National Bureau of Standards in specially built containers to protect workers from radiation hazards

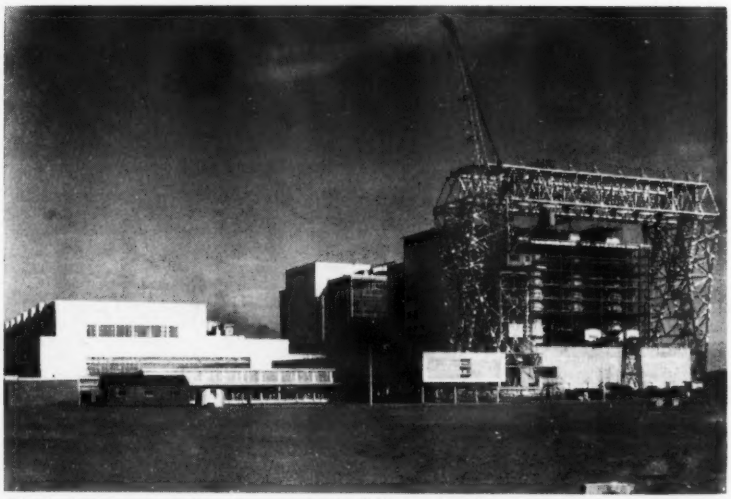
Britain's Nuclear Twins

BERKELEY and BRADWELL

CONSTRUCTION of the Central Electricity Generating Board's first two nuclear power stations is now in its fourth and last year. At both sites civil engineering work is virtually complete and the mechanical engineering is some three-quarters of the way to being finished. Work is concentrated on reactor installation.

Officially there is no competition between the two consortia building the stations as to which will be finished first. Indeed, since the consortia have joined forces to build further nuclear power stations together there would seem to be little point in such rivalry. In any case, it is most likely that whatever the relationship between the companies the stations would have been, and will be, handed over to the Generating Board at about the same time.

Despite the official view, however, it would be less than human to expect there not to be, amongst the men working on site at least, some sort of private, friendly, rivalry. There are still people who are proud of doing a job well and at the same time beating the next man to finishing it first. Such feelings exist down at the nuclear station sites and that they exist is shown by the way completion date forecasts are worded.



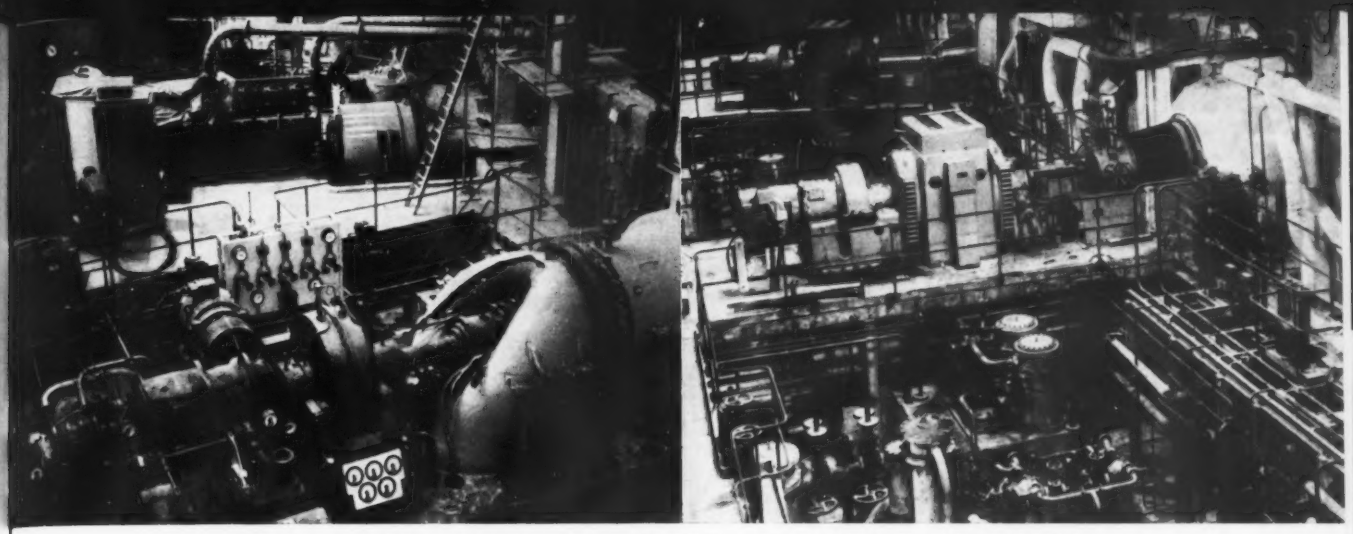
Work started on Berkeley (*top*) and Bradwell (*bottom*) nuclear power stations over three years ago. Both should be completed in about twelve months' time

At Bradwell, where the Nuclear Power Plant Co., are building a 300 MW station, the hope is that the first reactor will be completed by " the end of this year " and the second one by " mid-1961." At Berkeley, the site of the 275 MW station being built by the AEI-John Thompson Nuclear Energy Co., it is being said that No. 1 reactor should be ready some time " during the first quarter of next year " and No. 2 " during the third quarter." On examination there is not really much difference in the forecast dates as would at first appear.

Work started on the sites of both stations in January, 1957. Both are six months behind the original schedule. The principal cause of this delay has been the change in moderator design necessitated after the Windscale accident. Some way had to be found to prevent the build-up of energy and heat in the graphite, particularly in the lower part of the moderator. What has been done is to encase the graphite blocks in Magnox sleeves. At Berkeley this entailed the complete re-machining of about half of the graphite blocks ordered for the moderator.

There was also the problem of the contraction of graphite after it had been in a reactor for some time to be overcome. Such contraction, it has been found results in a looseness of the moderator. The solution has been found to be to fit protuberances to the inner wall of the pressure vessel to hold the moderator in place.

Because of different working methods progress at similar sections



Section of one of the two blowerhouses in reactor building No. 1 at Berkeley (*left*) and Bradwell (*right*)

of the two stations is not always at the same level. Graphite laying is, for instance, more advanced at Berkeley than at Bradwell. Indeed, down in Gloucestershire they seem ahead in all aspects of work on the reactors. On the other hand, Bradwell would appear to have progressed more on the electricity generating equipment side and in the installation of auxiliary plant.

At Berkeley pressure vessels for both reactors have been stress relieved and pressure tested and graphite laying in the first one all but complete. The boilers for the first reactor have been cleaned and tubed and work is progressing well on the installation of the control and burst slug detection equipment. Work on the cooling pond that serves both reactors is also advancing well.

Four 83 MW turbo generating sets are being installed in the turbine hall. At the time of a recent press visit No. 1 set was virtually complete and No. 2 two-thirds complete.

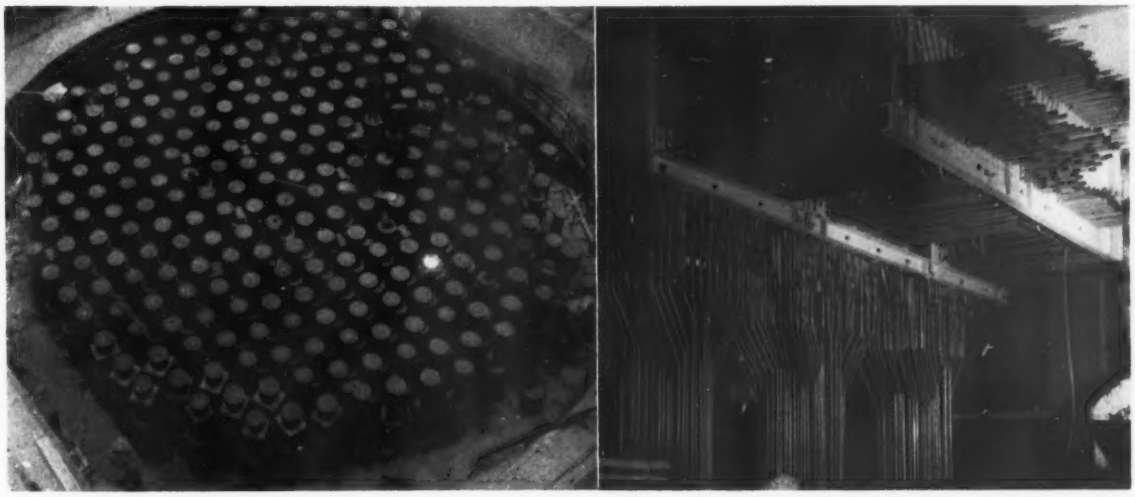
At Bradwell, graphite laying in the first reactor has only just recently started and the second pressure vessel only recently pressure tested and stress relieved. Initial tests on the gas circulating systems have been made and the installation of the pipework for the burst slug detection equipment is well in hand. The cooling pond plant is well advanced and the de-ionization plant installed.

In the turbine hall the first three of the six 58 MW turbo generators to be installed are erected and work on the fourth and fifth units is in hand. Eighty per cent. of the work on the auxiliary turbine equipment is complete.

Touring the sites of the two stations, the visitor noticing the differences in working methods and differences in design cannot help but wonder at what will be the result of the contracting consortia's collaboration on future stations. Will, for instance, they use a Goliath crane for the main construction work as at Bradwell or tower cranes as at Berkeley? Will the design of the later stations follow Berkeley or Bradwell?

It is, in fact, understood that the Nuclear Power Group's (the name of the consortia's amalgam) design for the Dungeness station is based on the Nuclear Power Plant Co., ideas, while that for Sizewell may well be a station in which everything is enclosed in a single building.

Whatever the outcome of the collaboration between the builders of Britain's first nuclear twins, one thing is certain, they will make the use of the best in each.



Shapes and patterns at Britain's first two commercially operated nuclear power stations. (*Left*) The 256 standpipes on the pilecap of Bradwell's No. 1 reactor before the concrete has been poured. (*Right*) Some of the 3,275 gas sampling tubes from the fuel channels in Berkeley's first reactor. They are connected to burst slug detection equipment

Westminster talks about...

by Peter Lewis — Our Parliamentary Correspondent

IN spite of the predominance of nuclear weapons, the public should be grateful to members for the vigilant watching brief that many of them hold on the progress and hazards of the peaceful application of nuclear science. **Mrs. Joyce Butler** (La./Co., Wood Green) was particularly interested in fall-out, and wished to know what elements were present in radioactive particles of measurable size in fall-out in the U.K., and whether there were figures available to show that suspension of hydrogen bomb tests had virtually removed such dangers. In written replies, **Mr. Derek Walker-Smith,** the Minister of Health, as representing the Minister for Science, said that radioactive elements in fall-out were mainly those arising from fission products such as strontium-90, caesium-137, zirconium-95 and niobium-95, plus elements produced in materials near the explosion and in the nuclear device. Regarding fall-out the Minister stated that last autumn showed a very marked fall in radioactivity over the U.K., compared with earlier in the year, partly due to a seasonal decline.

Milk in Wales . . .

Eisteddfods and Bardic ballads beloved of the Celts do not prevent them from being very much alive to contemporary dangers of a less metaphysical aura, and both **Mr. Tudor Watkins** (L., Brecon and Radnor) and **Mr. Thomas** (L., Cardiff West) were concerned about facilities for the determination of Sr90 in their country's milk. Mr. Walker-Smith referred Mr. Watkins to the report published in 1959 by the Agricultural Research Council's Radiobiological Laboratory, which gave figures for the average level of Sr90 in milk for Wales and other regions. Mr. Thomas, who wanted more facilities for such milk testing available in Wales, was told by the Minister that, due to the intricate laboratory processes involved, centralization was better than duplication, and that present arrangements, which included Wales, were not inadequate. Mr. Walker-Smith further pointed out that the report to be published shortly by the Radiobiological Laboratory would give Mr. Watkins the information he required on the frequency and location of radiation tests on Welsh pasture, grass, soil and sheep bones.

Marine propulsion . . .

Members show an unflagging interest in nuclear propulsion for ships, and **Mr. Sydney Irving** (La/Co., Dartford) asked if the Minister of Transport would give support to the building of an experimental ship of this type, as advocated by the U.K. Chamber of Shipping. Subject to the receipt of tenders already invited for prototype marine nuclear units, the question of ordering such a ship, replied **Mr. Marples,** would be considered. At the same time account would be taken of progress made with types of reactors other than those specified in the tenders. Meanwhile he would discuss with shipowners their possible formation of a consortium to own and operate the ship.

Marine Safety . . .

Mr. Awbery (L., Bristol Central) was more concerned with the regulations governing the operation of such ships, rather than their propulsion, and asked what steps Mr. Marples had taken to bring the matter before the forthcoming Safety at Sea Conference, and whether he would propose that any regulations laid down be applied internationally. The Minister assured Mr. Awbery that the proposals in the Report of the Committee on the Safety of Nuclear-powered Merchant Ships* would be placed before the Conference, but it was premature to seek international application. Contrary to Mr. Awbery's belief, the Minister was quite certain that the oceans would not be cluttered with nuclear propelled shipping within the next three years. The Minister promised to bear in mind the pertinent question put by **Mr. Rankin** (La./Co., Govan) regarding the berthing of such shipping near heavily populated areas.

**See page 219 of this issue for details of this report.*

The Admiralty . . .

A shift of scene took place when the Civil Lord of the Admiralty, **Mr. Ian Orr-Ewing,** replied to an enquiry by **Mr. David Price** (C., Eastleigh) on the Admiralty's policy for development of nuclear-propulsion. The Civil Lord announced that substantial effort was being put into research and development of this nature and essential facilities for the development of reactors for British submarines were being provided by the shore-based prototype test reactor at Dounreay. **Dame Irene Ward** (C., Tynemouth) wished to be assured that the Admiralty would disseminate any knowledge it gained from its researches. The Admiralty had no desire to create a closed shop on such matters, and was in touch with the Minister of Transport, said the Minister.

. . . Dounreay Progress

The prospects of power output and reductions in costs resulting from fast breeder reactors, prompted **Mr. Roy Mason** (L., Barnsley) to ask the Minister for Science for a statement of the progress at Dounreay. **Sir David Eccles,** Minister of Education, replied for the Minister for Science, who had been informed by the AEA that the reactor at Dounreay had been running at low power since November 14th last year, and that while the development of the fast breeder reactor would ultimately mean a reduction in costs, it was too early to evaluate such improvements.

Time's inexorable march was brought home when Mr. Mason asked what consideration the Minister had given to the problem of dismantling used nuclear power installations such as Windscale. He also wondered if future designs incorporated subterranean nuclear furnaces. Sir David in a written reply stated that the reactor vaults at Windscale had been sealed in such a way as to prevent exterior hazard.

(*Continued on page 237*)

PEOPLE... in the NUCLEAR NEWS

The first research grant under the Exchange and Training Programme of the International Atomic Energy Agency has been awarded to **DR. R. P. AGARWALA** of India. A graduate of the Agra College, India, and the Imperial College of Science and Technology, London, Dr. Agarwala will undertake 12 months' research in solid state physics and chemistry at the Massachusetts Institute of Technology.

MR. R. E. F. SYKES, associate member of the Institution of Works Managers, has been appointed general manager of Griffin & George (Laboratory Construction) Ltd., a subsidiary of the Griffin & George Group, manufacturers and suppliers of scientific instruments and equipment.

Following the appointment of **MR. R. N. MILLAR** as managing director of the engineering group of The General Electric Co., Ltd., who will move his headquarters to Magnet House, Kingsway, three new appointments have been made at the company's engineering works at Erith, Kent. They are as follows:—**DR. K. J. WOOTTON,** manager of the Atomic Energy Division, becomes general manager of the Erith Works, **MR. C. J. O. GARRARD,** manager, southern sales, is appointed deputy general manager of Erith Works, and **DR. H. K. CAMERON,** manager of the chemistry and engineering division, becomes manager of the atomic energy division. Dr. Wootton, born at Watford in 1921, was educated at Watford Grammar School and The Imperial College of Science and Technology, London. Following a period as a research engineer with the Shell laboratories at Thornton, he joined the Royal Air Force in 1942 and was commissioned in the Technical (Engineer) Branch. After the war he returned to Imperial College for three years to carry out heat-transfer research, and then joined Vickers-Armstrongs, Ltd., as a research and development engineer. In 1951 he was appointed head of the mechanical engineering department, University College, Khartoum, and remained there until he joined GEC at Wembley in 1955. Soon afterwards he assumed control of engineering research and development in the GEC/Simon-Carves Atomic Energy Group. In 1957 Dr. Wootton was appointed assistant manager, and in April, 1958, became manager of the GEC Atomic energy division. Mr. Garrard was educated at King Edward's School, Birmingham, and the University of Birmingham. After working for six years in Germany and France he joined the Witton Works of GEC in 1934. In 1943 he became assistant manager of the switchgear works, and manager in 1947, and in 1956 he was appointed manager of the switchgear and transformer works. Since 1958 he has been in charge of the company's engineering sales in Southern England. Dr. Cameron was educated at Colfe's Grammar School, Lewisham, and University College, London. He has also been at the University of Munich and at the Technical University, Vienna, where he was engaged on physical chemistry research. Dr. Cameron joined GEC at Wembley in 1930 where he developed an air depolarized battery and special carbon electrodes for search-lights. After the war he was associated in the early days of Harwell on several research projects such as those on graphite and isotope separation. In 1952 he was appointed manager of the chemistry and engineering division at Wembley covering chemical, metallurgical and materials work generally as well as mechanical, control and heating engineering.

Mr. C. J. O. Garrard

Dr. K. J. Wootton

Dr. H. K. Cameron

The Lyons Jones chair of Physics at Liverpool University, previously held by the late Professor H. W. B. Skinner, has been given to **PROFESSOR J. M. CASSELS,** FRS, at one time professor of experimental physics at the university. Professor Cassels was, from 1944 to 1947, at the Cavendish Laboratory, Cambridge, where he was engaged on nuclear energy research. In 1949 he became a junior research fellow at Harwell and the following year a senior research fellow. In 1956 he was appointed to the experimental physics chair at Liverpool from which he resigned in 1959 to go to Cornell University.

Marconi Instruments have appointed **MR. S. G. SPOONER,** formerly their production manager, as works manager. He will be responsible for manufacturing activities, industrial relations, work services and welfare.

New managing director of Fairey Engineering Ltd., is **MR. L. R. E. APPLETON,** OBE, MA, MIMechE, who has been chief of Fairey Aviation's Weapon Division since 1950. Another new appointment is that of **MR. P. J. DUNCTON,** BSc, ARCS, a director, as general manager of the Heston Works. **MR. H. G. GREGORY,** MIProdE, remains director and general manager of the company's Stockport factory.

DR. WALTER K. STROMQUIST, supervisor of the reactor systems section of the Westinghouse Electric Corporation's nuclear power department, has joined Aloc Products Inc., He has been appointed chief of plant systems engineering in the company's power nuclear engineering department.

N-Shipping Safety

(*Continued from page 219*)

course and be appropriately certificated or "licensed." It is felt that a suitably trained deck officer or engineer could carry out necessary health physics duties, and a certificated engineer officer could well look after any radiological equipment installed in the vessel.

Fixed monitoring equipment is recommended for various parts of a ship and regular checks and readings should be made and recorded. One point of interest here is the suggestion that although in a properly designed nuclear ship cargo should not be subjected to neutron irradiation monitoring of cargo in the first fleet of nuclear ships should nevertheless be carried out.

Before entering a port a nuclear ship should be subject to inspection by a competent official who will issue an "Entry Certificate." on finding that the ship complies with appropriate requirements.

The committee spent considerable time in examining the special problems of salvaging nuclear ships. Their principal recommendation is that a team of experts from the Atomic Energy Authority, Admiralty, and other appropriate bodies should be established for advising the salvaging industry on relevant techniques and equipment.

Recommendations are made as to possible steps that should be taken by the Government to ensure proper control of the nuclear ships using British ports. Legislation, it is felt, would be necessary at a fairly early date. There are also suggestions for relevant documentation.

'NUCLEARIST' writes . . .

RETIREMENT, except in the case of a few military commanders, usually means sliding back into oblivion. Not so for "Oswald," for he intends to be more in the public eye then ever before in his career. "Oswald" is an apparatus formerly used for thermonuclear research at the AWRE, Aldermaston, and now on view at the Science Museum, South Kensington. Its condenser bank and switchgear deliver a heavy current burst into a low pressure gas in a straight quartz tube. The 144 spark gaps, operated in parallel, function within a few microseconds. "Oswald" was the first British machine to produce neutrons in a gaseous discharge, and that was in 1957. How many of us can retire after a mere three years' service?

* * *

While fusion glows with future prospects, present reactors must rely on fission. In the field of research reactors, the Hawker-Siddeley Nuclear Power Co., Ltd., is to be congratulated on securing an order from Holland for their 10 kW "Jason," to be erected at Petten. It will take a long time to catch up on the lead gained by the Americans in the research reactor market, but this order shows that the hopes are not forlorn ones.

* * *

Turning to power, the spotlight is now on India. The Indian AEC's power programme has had to be tailored to fit the slender financial resources of the country, in spite of Dr. Bhabha's drive and enthusiasm. Following a Russian visit, however, there is a high chance that India will accept a Soviet offer to build a nuclear power station near Bombay, and without any "strings." If the Russians do not insist that fuel is returned to the Soviet Union for reprocessing, then the Indians may soon have a supply of plutonium. They might then revise their averred intention to consider only the peaceful uses of the atom, especially if Chinese threats increase. Firms in Great Britain and the U.S.A. would be only too willing to build a power station in India, but who would pay for it? Certainly not the Indians. Since power requirements are becoming ever more and more urgent, India may well have to turn to the suitor offering the most handsome bouquet.

British nuclear power developments appear to have been the subject of some discord. The breakdown of the agreement between General Electric-Simon Carves Atomic Energy Group and Atomic Power Constructions, who had intended to submit a joint tender for the Dungeness station, certainly gives food for thought. Is it that they really find insuperable the difficulties involved in organization of the joint project, or is it that there are fundamental differences of opinion on the more technological aspects of the job? Since the advent of nuclear power there have been many attempts at collaboration between firms, and this is not the first time that a breakdown has occurred. In such troubled times one should not be too perturbed if a handshake is followed by a cold shoulder, but concord would have been a happier augury.

* * *

The Marianas Trench in the Pacific Ocean was once thought to be a safe place for disposing of radioactive wastes, until those who descended to 37,700 ft in Professor Piccard's bathyscaphe saw fish at that depth. It was clear that oxygen must be available there, and this meant that currents must exist between the deeps and the surface. Should any leakage occur from a container of radioactive waste dropped in the Trench, activity could find its way to the surface, where it might present a very real hazard. However, such a danger, like that from fall-out, could be conveniently overlooked should there be no dumping ground more convenient than the Trench!

* * *

Why cannot British firms present their annual reports in a more attractive form than the usual bald and uninteresting statement of balance sheets? More of them could well follow the example of the American firms. From ALCO Products, Inc., comes a 1959 report of 24 large pages, well laid-out, and giving a clear statement of the firm's activities and financial status. There are, too, striking photographs of railways, heat exchangers, gear-cutting, spring-testing, computers, missiles, and other aspects of the firm's work. Another equally handsome production comes from Worthington, in the same size and format as that from ALCO. Again, this tells the same story of progress in the same bright way. It includes a diagram of the sizes and shapes of all 25 nuclear submarines of the U.S. Navy, together with many illustrations of the firm's manufacturing centres, which make pumps, turbines, valves, coolers, water meters, compressors, etc.

* * *

The British Safety Council is to be congratulated on its invaluable booklet, "Safety Spotlight—Isotopes," which, based on information from authoritative sources, contains a summary of applications of isotopes on industry, notes on worker protection from radiations, transport of radioactive materials, the organization of a radiation protection service, and some notes on accidents. It is to be hoped that every possible publicity will be given to this handbook, which should be made readily accessible in every works, college and research institution where radioisotopes are used and handled.

* * *

Humanity shows itself at the AERE, Harwell, where £2,500 is to be collected to bring to Britain a refugee family, to house them, and to provide work for the breadwinner. It is good to know that the backroom boys are not so far up in the clouds that they cannot see the difficulties affecting so many around them in Europe and elsewhere. There are tens of thousands of stricken folk who cannot afford to wait for the millenium promised by atomic energy.

* * *

The £2,830,000 approved for the DRAGON Reactor project at Winfrith Heath for 1960-61 does not seem excessive for such a valuable piece of collaborative work. The sudden death of the Chief Engineer, Anselm von Ritter, just after taking up duties in January, was a tragic blow. His successor is Gianfranco Franco, Acting Director of the Ispra Nuclear Centre, Italy.

NUCLEAR NEWS

- **New Harwell Division** *(This page)*
- **N-Power in N. Scotland?** *(Page 236)*
- **N-Briefs** *(Page 237)*

Harwell Reactors

A NEW division has been formed at Harwell. It is the research reactors division. It will have responsibility for the operation, maintenance, safety and development of Harwell research reactors and their facilities, including rigs, loops and auxiliary equipment. In addition, the division will undertake physics experiments necessary for the solution of design and operational problems and studies on possible future research reactor systems. The division has been formed from the research reactor group of the former reactor division, now mostly transferred to the Atomic Energy Establishment, Winfrith, and the reactor services group, previously part of the engineering division. Senior posts in the division will be open to both scientists and engineers with the positions of division head and deputy division head normally held one by a scientist and the other by an engineer. In addition, scientists will be encouraged to enter the operations group of the division and will be eligible for posts as chief pile operators.

N-Ship Hazards

DANGERS arising from collision of nuclear-powered ships might mean the establishment of international shore control stations for certain congested areas, such as the English Channel. This was advocated by Mr. R. Y. Bell, chief nuclear engineer of Yarrow & Co., Ltd., Scotstoun, Glasgow, when he spoke at Paisley Technical College recently. Suitable control systems might be worked out on the lines applying on international air-line routes. Since only large ships were meantime being considered for nuclear propulsion, it was possible to keep the installation well away from the ship's side and to provide substantial protection by collision barriers to absorb the shock of impact and protect the reactor. Even so, there had been exceptional cases where large ships travelling at high speed had collided and their hulls had been heavily penetrated. This could become a serious hazard in a nuclear ship, and provision would require to be made against such a contingency.

Scots Unite

THE four Scottish universities and the Royal College of Science and Technology are co-operating to organize a full training system for scientists proposing to make nuclear power their field of operation. Dr. S. C. Curran, principal of the Royal College of Science and Technology, Glasgow, speaking at a meeting organized by the British Lighting Council emphasized the important part which nuclear power would play in industry and on the pattern of life in general. Scotland had taken a leading part in many fields of engineering and it was essential that the opportunities of nuclear technology should be fully appreciated by those responsible for the training of nuclear engineers. Several English universities had made their aspirations known in this context. The Scottish universities and the Royal College realized the need to provide modern instruction in all branches of nuclear engineering and believed that a strong case could be made out for the location in Scotland of one teaching reactor. They were now working together on this project.

E.N.E.A. Report

THE European Nuclear Energy Agency of the OEEC has published its second report to the Council of Europe. In contrast to the first report, published in September, 1958, and covering the first six months of ENEA's existence, this new document is largely devoted to recording work done rather than proposals under consideration. The 18-month period now reviewed has seen the setting up of the first three joint research undertakings sponsored by the Agency, and the start of their operations. It has also seen progress in work on questions of health and safety, information and training, and third party liability in cases of nuclear incidents. The international company EUROCHEMIC, created by the Convention of December 20th, 1957, was constituted in July, 1959. A study and research office of some 50 people, established in 1958 within the framework of ENEA, is engaged on working out the pre-project for the plant and laboratories to be built at Mol in Belgium. Discussions are going on with the firms in participating countries which will be responsible for executing the project. Work on the site has begun and the safety problems arising out of the operation of the plant are the subject of special study. The boiling heavy water reactor at Halden, Norway, which has been the subject of joint operation since the Agreement signed at Oslo on June 11th, 1958, has been functioning since June, 1959; at present it is being used to carry out a programme of low-power experiments relating to the physics and control of the reactor. The staff of the project is about 100 and nearly half the scientific staff come from countries other than Norway. On March 23rd, 1959, an Agreement was signed for the joint construction and operation of a high-temperature gas-cooled reactor (DRAGON) at the Winfrith Establishment in the United Kingdom; the research programme has been approved by the Board of Management of the project and is being carried out by an international team which already amounts to more than 100, half of the scientific staff coming from the Continent. The research work as well as the construction of DRAGON, although based on the earlier work of the United Kingdom Atomic Energy Authority, will be carried out with the co-operation of all participating countries on the basis of international invitations to tender which are already under way. These three joint undertakings represent a financial commitment of nearly $70 m. over a period of five years and the total staff will be about 700.

I.A.E.A. Assistance

THE board of governors of the International Atomic Energy Agency have approved the director general's proposal that a preliminary technical assistance mission be sent to certain Mediterranean and African countries. These are Greece, Morocco, Tunisia, Sudan, the Ivory Coast and the Federation of Mali. The mission will collect information and advise on nuclear energy programmes in the countries visited and will help in formulating requests for assistance which the International Agency is in a position to render. The team will include experts in the agricultural and medical applications of radioisotopes, nuclear research and power, training of scientists and technicians, prospecting and mining of nuclear raw materials. It is expected that the mission will leave Vienna at the end of April and stay for approximately one week in each country.

Letter to the Editor

"Red-shift" Experiment

SIR: In your April issue "Nuclearist" makes an unfortunate slip in commenting on the "red-shift" experiment at Harwell. He says that γ-rays are allowed to fall "in the earth's magnetic field," whereas he surely means *gravitational* field. (The earth's magnetic field, although also present, is irrelevant to this experiment).

Incidentally, although "Nuclearist" was not to know it at the time of writing, the conclusions of this experiment have since been challenged independently in a letter to the *Physical Review** and at the recent Liverpool conference of the Physical Society.

Yours, etc.,
JOHN W. GARDNER,
Atomic Power Division—English Electric Co., Ltd.

* L. I. Schiff, *Physical Review Letters*, *4* 215. March 1st., 1960.

More N-Power in Scotland

THE North of Scotland Hydro Electric Board may construct a nuclear power station in the North East within the next ten years, but this is conditional on improved economy of nuclear operation. Mr. A. A. Fulton, general manager of the North of Scotland Board commented on the situation when he spoke at the presentation of the Board's annual report. "Nuclear generation has not worked out just as cheaply as had been forecast and the only way we find it possible to bring down the cost at present is by enlarging the size of the nuclear station. The latest nuclear stations for which orders are being placed are of the 500,000 kW class, but we want something between 100,000 and 200,000 kW," Mr. Fulton said.

Effluent Exhibition

AN exhibition and convention on effluent and water treatment is to be held in London on October 18th-21st at the Seymour Hall. The exhibition will be the first of its kind and a wide range of equipment, plant and techniques are expected to be displayed. Among subjects covered at the convention will be analysis techniques, composting treatment, development of filtration and water treatment plant, river pollution, treatment of radioactive waste materials and waste water recovery. Full details of both the exhibition and convention can be obtained from the organizers, Thunderbird Enterprises Ltd., 140, Cromwell Road, London, S.W.7.

For Down Under

ADVANCED Technology Laboratories, a division of American-Standard is to supply a UTR-10 research reactor to the Australian Atomic Energy Commission. It will be located at the Commission's research establishment at Lucas Heights, New South Wales, with completion planned for late autumn. American-Standard was awarded the contract for the reactor in competitive bidding with other nuclear firms in the United States and the United Kingdom. The reactor, a dual purpose design for training and research, will operate at power level up to 10 kW and will be used by the Commission in the development of new and advanced reactor types. It is a graphite-water reactor using enriched uranium as fuel.

More SNAPS?

THE Martin Co., has received a $2.3m. extension of its contract with the U.S. Atomic Energy Commission for work in the field of isotopic power. The new extension is an outgrowth of earlier programmes which included the development of several electrical generating devices in the SNAP (Systems for Nuclear Auxiliary Power) series. In the SNAP units, heat produced by the spontaneous decay of a radioisotope material is converted directly into electrical energy. No moving parts are required, and the generators will continue to produce power for months or years, depending on the nature of the isotope used. Martin have received contracts for this type of work worth $8.5m. since early 1956.

Research Contracts

THE International Atomic Energy Agency has so far awarded 47 research contracts to scientific institutes in 20 countries and to one international body for research on radiation safety and protection, radioisotope applications and methods of applying safeguards against the diversion of nuclear materials to non-peaceful uses. While some of the research projects are meant to promote wider applications of radiation and radioactive substances, the majority are designed to reduce the hazards that may be involved in the peaceful uses of atomic energy. Countrywise, the contracts have been distributed as follows: Argentina 1, Austria 6, Belgium 1, Czechoslovakia 1, Finland 1, France 6, Federal Republic of Germany 1, Greece 1, Iraq 1, Italy 3, Japan 7, Netherlands 1, Norway 3, Philippines 1, Poland 3, Sweden 2, Switzerland 2, United Kingdom 2, U.S.A. 1 and Yugoslavia 2. On contract has been awarded to an international working group on oceanographic radioactivity. The total expenditure to be incurred by the Agency on these projects is about U.S. $400,000.

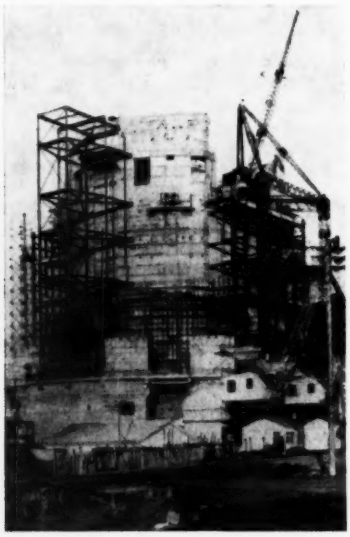
Postgraduate Course

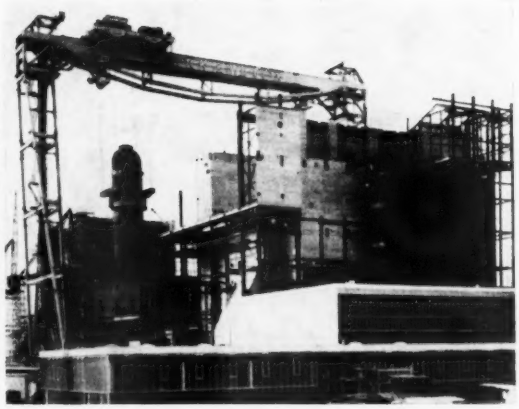
APPLICATIONS for admission to the 1960-61 postgraduate course in Nuclear Technology at the Imperial College of Science and Technology, London, should be made before June 1st. The object of this course, the second of its kind, is to provide students with a general training in the chemical, chemical engineering, and metallurgical aspects of nuclear technology. It is of a year's duration and satisfactory completion of it qualifies students for the award of the Diploma of Chemistry and Metallurgy. Fee for the course is £64. Further details and application forms are obtainable from the Registrar, Imperial College, London, S.W.7.

New Film from E.F.V.A.

"Isotopes" explains the meaning of "isotope," shows how their existence were first demonstrated by Sir J. J. Thomson in 1912 and how Aston in 1919 developed the first mass spectrometer and found that neon was made up of two isotopes of the atomic weights of 20 and 22. It then goes on to show how isotopes separated and the film ends with illustrations of the use of isotopes. It is intended for science specialists in Sixth Forms of Grammar Schools and for students at a similar level at Technical Colleges. It is in colour and runs for 15 min. It is available from the Educational Foundation for Visual Aids, 33, Queen Anne Street, London, W.1.

In Ayrshire and Somerset





(*Left*) The building for reactor "A" of Hunterston nuclear power station being built for the South of Scotland Electricity Board by GEC. (*Right*) Work in progress on the Hinkley Point nuclear power station being built for the CEGB by the English Electric-Babcock & Wilcox-Taylor Woodrow Atomic Power Group

N-Briefs

GHANA has been admitted to membership of the International Atomic Energy Agency. There are now 70 member states.

* * *

Winston Electronics Ltd., of Shepperton Middlesex, have become a wholly owned subsidiary of the Dynamics Corporation of America, New York.

* * *

A nuclear power section has been opened at Moscow's Polytechnical Museum with working models showing reactor processes, chain reactions and heat and power production.

* * *

The Martin Co., Baltimore, has received a $335,000 contract from the U.S. Atomic Energy Commission to develop a series of computational codes for small pressurized water reactors.

* * *

Italian engineers who will hold key posts in the British designed nuclear power station being built at Latina, near Rome, are now receiving intensive training in reactor control and operation at Calder Hall.

* * *

Tracerlab Inc., are to supply continuous radiation monitoring systems for the Enrico Fermi nuclear power station Detroit, and the I Piqua power reactor plant, Piqua, Ohio. The contracts are worth a total of about $175,000.

* * *

HERALD, the MERLIN type reactor at the Atomic Weapons Research Establishment, Aldermaston, recently went critical. It is light water moderated and cooled and has a continuous output of 5 MW. It was designed and supplied by the AEI-John Thompson Nuclear Energy Co., Ltd.

* * *

A detergent which removes contamination by radioactive metals and their salts has been developed by the UKAEA. It has been patented and a licence for its manufacture granted to the Authority. The detergent can be made in various forms and can be used on textiles, plastics, paints, rubber and metals.

* * *

An order worth over £300,000 for high-voltage testing equipment has been placed with Ferranti Ltd., by the U.S.S.R. This is the largest contract for high-voltage testing equipment of this type ever placed with a British manufacturer. The contract was negotiated through v/o Machino-import of Moscow.

* * *

The stators for the four 83 MW turbine-generator sets which Associated Electrical Industries Ltd., are supplying for the Berkeley nuclear power station are being transported to the site on a 32-wheeled trailer, said to be the first of its kind in the country. The stators weigh 118 tons and are 21 ft 5 in. long, 12 ft 10 in. wide and 13 ft 1 in. high.

* * *

Details of the contract for the supply of uranium fuel for the nuclear power station to be built at Tokai Mura. Japan, were established recently when Mr. Diagoro Yasukawa, president of the Japan Atomic Power Co., and Sir Roger Makins, chairman of the UKAEA, signed the Heads of Contract. The detailed contract will not be signed until some time early 1962, about a year before the first deliveries of fuel are required.

* * *

An international symposium on the chemical effects of nuclear transformations is to be held in Prague, Czechoslovakia, on October 24th-27th. Subjects to be covered will include the chemical effects of nuclear transformations in inorganic and organic solids, liquids and gases; post irradiation effects and annealing phenomena; reactions of ions produced by artificial acceleration; applications of energetic-atoms chemistry and recoil labelling of compounds. The symposium is being organized by the International Atomic Energy Agency.

* * *

THE Dounreay Atomic Energy Research Establishment, Caithness is to provide facilities for visitors this coming year; this follows the immense interest shown in the station by holidaymakers visiting John O'Groats and other northern centres. The control tower on the former airport will be used as an information centre. A model layout of the plant will be installed so that visitors can be shown the basic layout and inspect the station from the heights of the tower. No direct entry to the plant will be allowed.

* * *

Kennedy and Donkin, the Consulting Engineers, have been appointed by the Brazilian Atomic Energy Commission to advise them on a projected 200 MW nuclear power station to be built between Rio de Janeiro and Sao Paulo. Kennedy and Donkin are Consulting Engineers for the Hunterston nuclear power station. They are also currently advising the Swedish State Power Board in the selection and preparation of a nuclear power station site. In addition, they have acted as advisers to the Societa Elettronucleare Nazionale, Italy.

Recent U.K. Contracts

MITCHELL ENGINEERING Ltd., have been awarded a contract for civil engineering work at Windscale in connection with the AGR project. It is worth £154,000.

WILLIAM BAIN & Co., Ltd., are to supply and erect the structural steelwork for the thermonuclear research centre to be built at Culham, Oxfordshire, by the UKAEA.

ELLIOTT NUCLEONICS Ltd., are to supply the reactor flux scanning equipment for the Trawsfynnyd nuclear power station.

In "People in the Nuclear News" on page 180 of NUCLEAR ENERGY, April, it was stated in our reference to the promotion of Sir John Wrightson, Bt, as chairman of Head, Wrightson & Co., Ltd., that Sir John "continues as sole managing director." Sir John, in fact, is joint managing director with Mr. Peter Wrightson. We apologize for any inconveniences this error might have caused.—*Ed.*

Parliamentary Report

(*Continued from page 232*)

Future methods would depend on the techniques available at the time. The siting of reactors underground was uneconomic, continued Sir David, and was not contemplated at present.

Mr. Wood circulated the accompanying tables in the Official Report, following a question by **Mr. Lee** (L., Newton) for yearly figures of all generating plant planned by the Central Electricity Generating Board from 1960 to 1965. The Minister said he could not extend the table to 1965 as the plant commissioning programme for that year had not been fixed.

Table I.—New Generating Plant of the Central Electricity Generating Board expected to come into operation in the years 1960-1964

Year	*Conventional plant*	*Nuclear plant*	*Total*
	MW	MW	
1960	2,263	—	2,263
1961	1,978	575	2,553
1962	1,846	250	2,096
1963	1,569	500	2,069
1964	1,877	500	2,377

Table II.—Total Output Capacity of CEGB Plant expected to be in operation at the end of each Year

Year	*Total output capacity*	*Nuclear proportion*
	MW	per cent.
1960	27,130	—
1961	29,359	2.0
1962	31,143	2.6
1963	32,799	4.0
1964	34,833	5.2

Table III.—Estimated Proportion of Total Power Stations Output to be provided by CEGB Nuclear Plant

Year	*Nuclear proportion*
	per cent.
1960–61	—
1964–65	8

Table IV.—Estimated Fuel Consumption. (million tons coal or coal equivalent in other fuels)

Year ending March 31st	*Total*	*Nuclear component*
	(approx.)	
1960–61	54	—
1964–65	64	4–5

TWO
HIGH EFFICIENCY
CYCLONE
FANS

Maximum total efficiency over
90%

with non-overloading backward curved impellers

Eminently suitable for air conditioning and ventilating installations with large volumes and high water gauges—particularly High Velocity systems.

Maximum total efficiency over
75%

MATTHEWS AND YATES LTD.

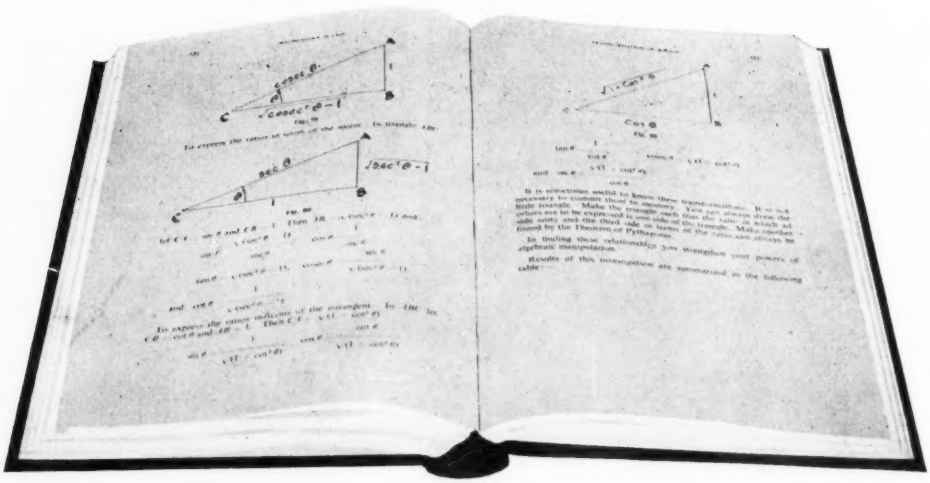
HEAD OFFICE & WORKS
CYCLONE WORKS, SWINTON, MANCHESTER
Telephone: SWinton 2273 (4 lines)

LONDON OFFICE
135 RYE LANE, PECKHAM, LONDON S.E.15
Telephone: NEW Cross 6571 (4 lines)

Also at: Glasgow Leeds Birmingham Cardiff Bournemouth

MATHEMATICS IS EASY

by D. S. Watt, B.Sc., M.I.N.A.



Size of the Book 8½ in. × 5½ in. and is in blue cloth. Over 480 pages with 109 diagrams.

Send 48/- (*which includes postage*) *for immediate attention*

PRINCES PRESS LIMITED, 147 VICTORIA STREET, S.W.1

— the Stamp of experience which is on all Atomic Energy Equipment manufactured by Graviner. We can make almost anything in this rather new sphere of activity, whether it be a lead-filled shielded container, a Thulium storage magazine, a magnet for neutron beam focusing or a 20 ton mobile cell unit with viewing windows and handling equipment. We specialise too, in the machining of graphite. Indeed, with the recent addition of 12,500 square feet of factory space we can deal with anything from the making of a tiny graphite spring to a Reflector for a Reactor — all under controlled clean conditions. If therefore you have a Development or Production problem, our Nuclear Energy Division will be very pleased to help you. Won't you pay a visit to the Gosport Factory and see what we can do?

GRAVINER

Contractors to The Atomic Energy Authority

FAREHAM ROAD · GOSPORT · HANTS · Telephone Fareham 2511

Also specialists in Airborne, Diesel Engine and Industrial Fire and Explosion Protection, Thermostats and Overheat Switches

Let

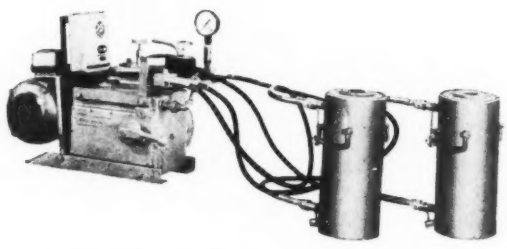
SIMPLEX

JACKS

take the weight

SIMPLEX offers the largest range in the World.—Standard production models up to 300 tons of the remote control type many having CENTRE HOLE construction for lifting or pulling with pull rods through the centre of the ram without torque.

Single and double Pump Hydraulic Jacks up to 100 tons



MULTIPLE OPERATION

Shut-off valves to control the lift of each ram

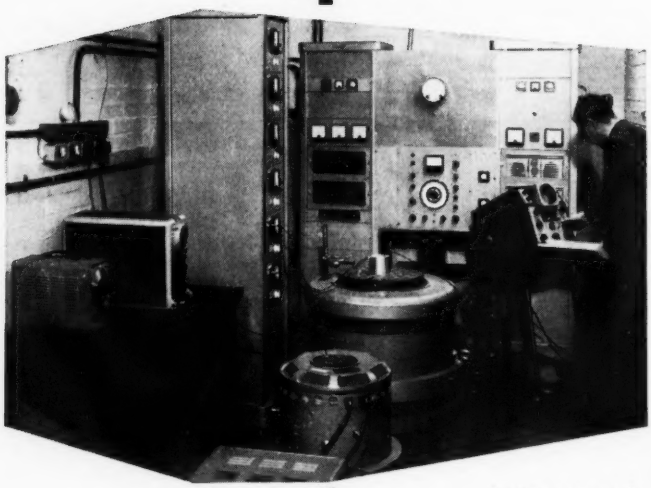
FOR LIFTING BRIDGES AND OTHER LARGE STRUCTURES

ALSO LARGE RANGE OF MECHANICAL JACKS
INCLUDING
JOURNAL AND BRIDGING JACKS
SPECIAL MODELS FOR
CABLE REELS
POLE PULLING
MOVING PLANT AND MACHINERY
ETC.

The Equipment & Engineering Co. Ltd.

2 & 3 Norfolk Street, London, W.C.2 Tel: Temple Bar 1088

vibration test laboratory



Photograph illustrates a corner of our Vibration Test Laboratory

In one of our London factories, we have a completely equipped Vibration Test Laboratory, manned by experienced engineers. The laboratory can accept Vibration work for customers who are unable to carry out their own tests, due either to heavy commitments or equipment not being available.

Range of Vibration Test Equipment

(1) 3,000 lb. thrust vibrator *(Type V1001)* with 10 KW drive amplifier *(Type 10K)* including automatic frequency sweep control *(Type SFO.1)*

(2) 750 lb. thrust vibrator *(Type V1000B)* with 2 KW drive amplifier.

(3) 550 lb. thrust vibrator *(Type V1000)* with 1 KW drive amplifier.

(4) 250 lb. thrust vibrator *(Type V999)* with 500 watt drive amplifier.

W. BRYAN Savage

designers and manufacturers of vibrators and amplifiers for modern industry

All enquiries should be sent to Vibration Test Dept.

W. BRYAN SAVAGE LTD 17, *Stratton Street, London, W.1* *Telephone: Grosvenor* 1926

DaS560NE

COBALT 57

Now available from stock

Specifications:

1. Radiochemical purity — > 98% — balance: other radiocobalt.

2. Specific activity—exceeds 100 mc/mg.

Price and Catalogue of other NSEC Carrier-Free Isotopes available upon request.

Nuclear Science & Engineering Corporation

P.O. Box 10901–Pittsburgh 36, Pennsylvania (USA)
Dept. M–8

APPOINTMENTS

NUCLEAR ENGINEERING

Development Engineers required for work on novel projects connected with nuclear and conventional steam-generating plant.

Applicants should preferably hold a mechanical or chemical engineering degree and should have some previous experience of the practical aspects in design or development of heat exchangers and high-pressure steam plant.

Commencing salary in range £900—£1,200 per annum. Contributory Pension Scheme.

Application should be made in writing, giving details of age, qualifications and experience, to:—

Staff Manager,
Foster Wheeler Limited,
3, Ixworth Place,
London, S.W.3.

DRAUGHTSMAN (H & V), knowledge of electrical work an advantage. Consulting Engineers. Five day week, L.V. State age, wage and experience. Box. No. 1026, NUCLEAR ENERGY 147, Victoria Street, Westminster, S.W.1.

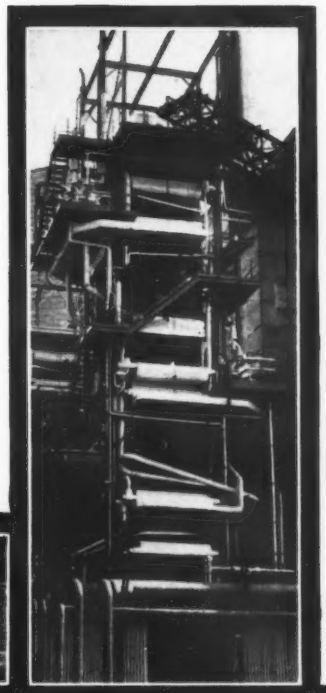
PROTOTYPES

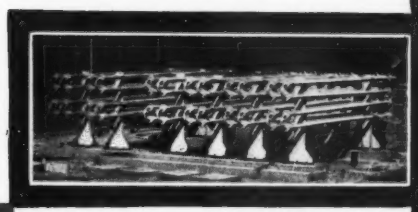
Design and Construction of Special Machinery
RESEARCH ENGINEERS LTD.
Northampton Grove, Canonbury, London, N.1.
CANonbury 4244 Wilmaket, Nordo, London

Printed and Published by Princes Press, Ltd., 147, Victoria Street, Westminster, S.W.1.

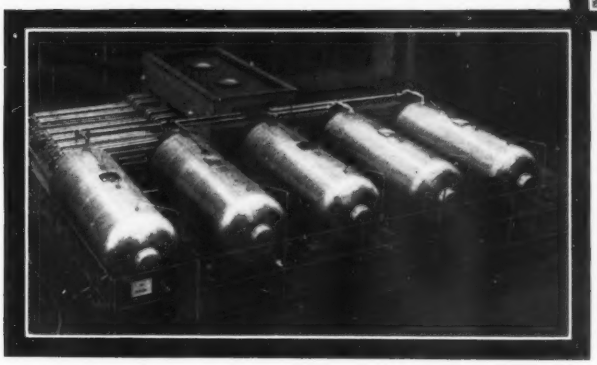
Conditions of Sale and Supply.—This periodical is sold subject to the following conditions, namely, that it shall not without the written permission of the publishers first given, be lent, resold, hired out or otherwise disposed of by way of trade except at the full retail price of three shillings and sixpence, and that it shall not be lent, resold, hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of trade; or affixed to or as par tof any publication or advertising, literary or pictorial matter whatsoever

Calder Hall
Chapelcross
Berkeley
Hunterston
Bradwell
Hinkley Point





DCL know CO_2



The use of carbon dioxide as a heat transfer medium in nuclear power stations raises many problems. Where storage and vaporization are concerned, The Distillers Company Limited know the answers; and they provided the installations for the purpose at both Calder Hall and Chapelcross.

Other similar, even larger, installations are now being designed or constructed by the Company for the Berkeley, Hunterston and Hinkley Point power stations. The Company has recently also obtained the contract for the supply of carbon dioxide to the Bradwell and Hinkley Point nuclear power stations.

The Distillers Company Limited
Chemical Division—Carbon Dioxide Department
Devonshire House, Piccadilly, London W.1
Telephone: Mayfair 8867

Between you and Boiler Corrosion..

An impenetrable shield of APEXIOR REGISTERED No.1

On guard, and constantly ready to fight against corrosion in boilers or steam raising plant is Apexior No. 1.

Applied as a thin film to surfaces which encounter water or steam temperatures between 170°—1000° F., Apexior No. 1 is an effective, low cost protection for expensive boiler plant. It cuts corrosion to an absolute minimum; reduces scale formation. Any scale which forms can be easily and speedily removed without danger of damage to plant as it is non-adherent.

Other advantages come with Apexior No. 1: heat transmission is improved; and since Apexior is an inert coating, feed water is left completely free from discolouration or contamination. Keep step with industry to-day—be boiler wise and Apexiorise.

For full information on all aspects of Apexior No. 1 write for Booklet " Preventing Boiler Corrosion. "

"Apexior" is being used at Stations throughout the U.K. Atomic Energy Authority.

BY APPOINTMENT TO
HER MAJESTY QUEEN ELIZABETH II
MANUFACTURERS OF PAINT
BRITISH PAINTS LIMITED

BRITISH PAINTS LIMITED Apexior Division

Portland Road, Newcastle upon Tyne 2

London · Liverpool · Sydney · Adelaide · Durban · Cape Town · Calcutta · Trinidad · New York · Dublin

OUR WORLD-WIDE SERVICE IS AT YOUR DISPOSAL FOR THE ASKING

BPL/A48